THE INSTITUTE OF PETROLEUM REVIEW

V.14 #167

November 1960

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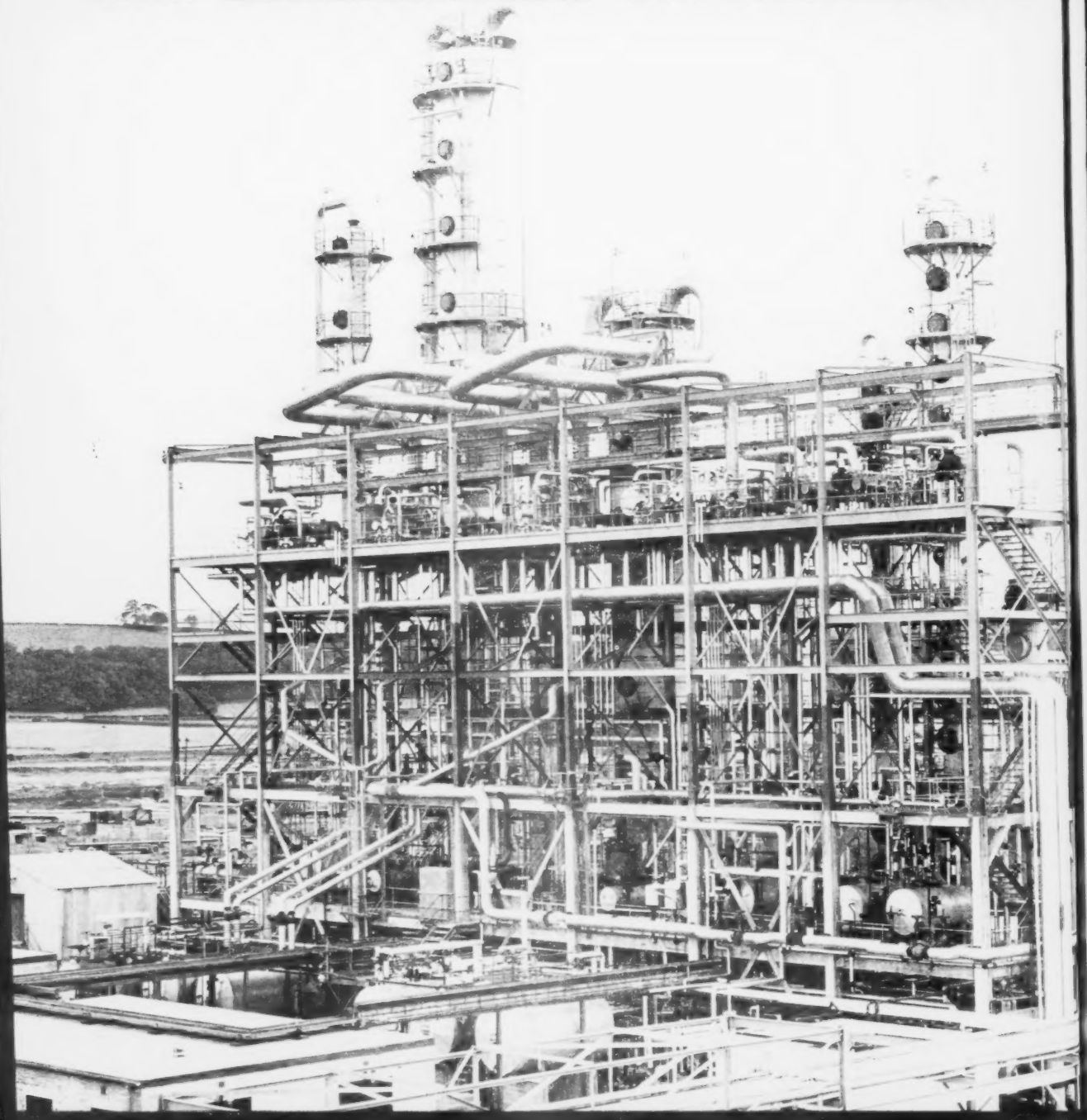

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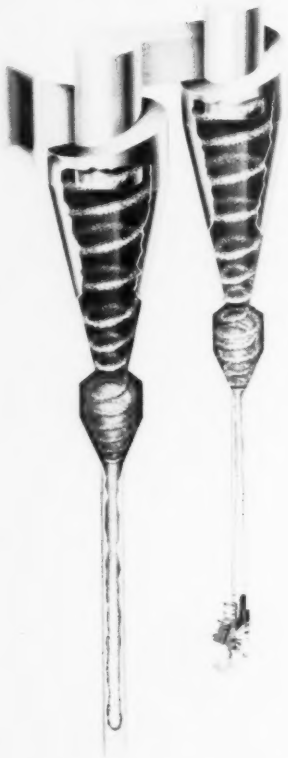

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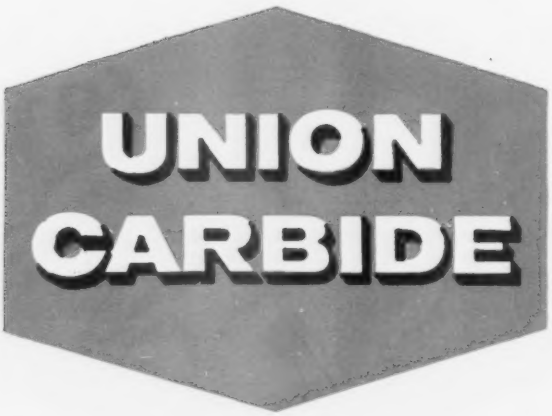

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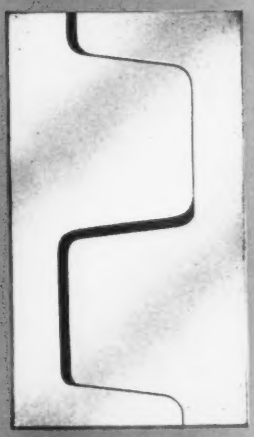
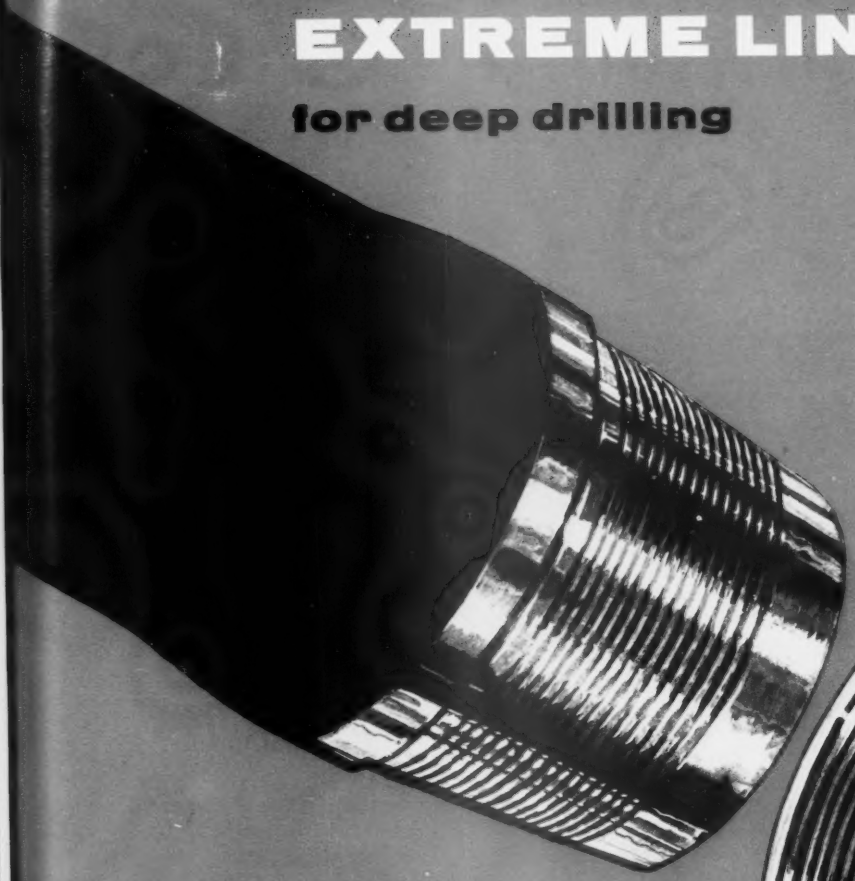
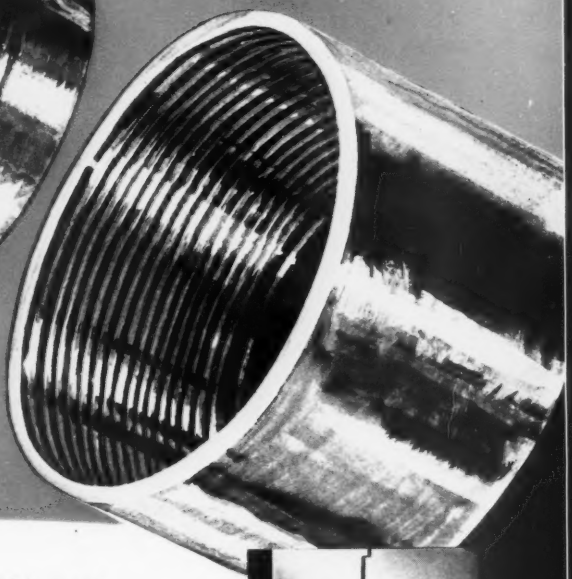


Engagement of thread





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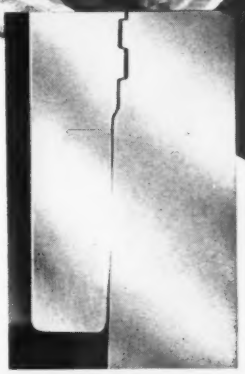

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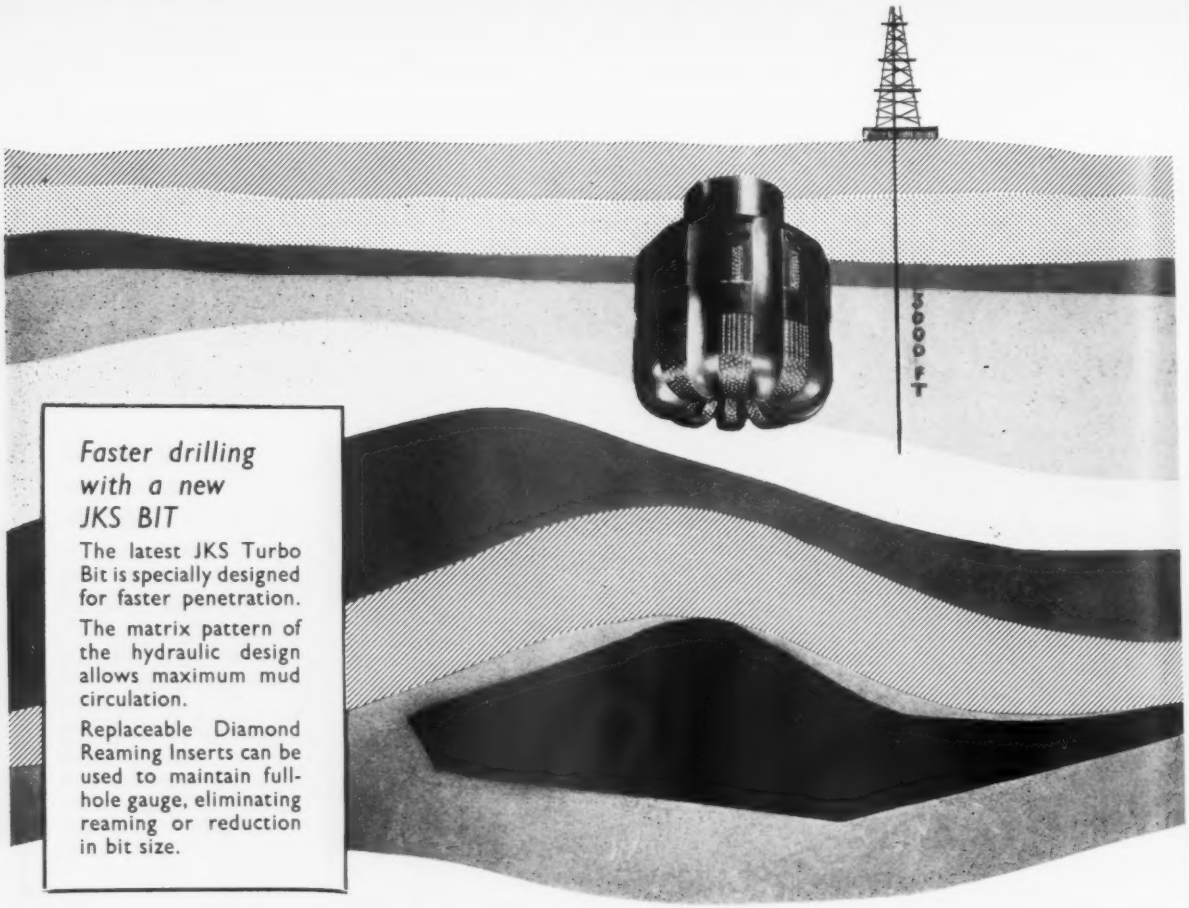

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Summary extract of the drilling log of MURNAU No. 2, Bavaria, by courtesy of PREUSSAG A.G.

Diamond Recovery 78%

1959	DEPTH	FOOTAGE	HOURS	PER HOUR	WEIGHT ON BIT	GALLONS	SOLID SANDSTONE FORMATIONS WITH QUARTZITE STRINGERS
SEPT 14	3598·41						
21	3998·31	399·90	77·60	5·02	18,20000 lbs.	490 p.m.	10½" DIAMOND TURBO BIT
21	3998·31						
	4004·87	6·56	7·50	·82	4 700 lbs.		6" ,, CORE BIT
22	4004·87						
24	4259·12	254·25	57·00	4·46	18/20000 lbs.	484 p.m.	10½" ,, TURBO BIT
25	4259·12						
	4267·33	8·20	9·00	·91	7000 lbs.	154 p.m.	6" ,, CORE BIT
26	4267·33						
OCT 12	4876·55	609·23	131·00	4·65	13/28000 lbs.	472 p.m.	10½" ,, TURBO BIT
13	4876·55						
14	4888·35	11·80	11·50	1·02	7000 lbs.		6" ,, CORE BIT
15	4888·35						
17	5195·75	307·40	64·50	4·76	18/20000 lbs.	484 p.m.	10½" ,, TURBO BIT
19	5195·75						
	5208·87	13·12	12·00	1·09	7000 lbs.		6" ,, CORE BIT
20	5208·87						
24	5500·20	291·33	99·80	2·91	11 16000 lbs.	484 p.m.	10½" ,, TURBO BIT
26	5500·20						
	5508·40	8·20	6·50	1·24	7/9000 lbs.	132 p.m.	6" ,, CORE BIT
27	5508·40						
31	5923·13	414·73	98·50	4·21	11 18000 lbs.	484 p.m.	10½" ,, TURBO BIT
NOV 2	5923·13						
	5936·25	13·12	10·00	1·31	7000 lbs.		6" ,, CORE BIT
13	5936·25						
DEC 12	6694·73	758·48	417·30	1·81	9 11800 lbs.	484 p.m.	10½" ,, TURBO BIT
14	6694·73						
15	6710·81	16·08	13·00	1·23	4 7000 lbs.	132 p.m.	6" ,, CORE BIT

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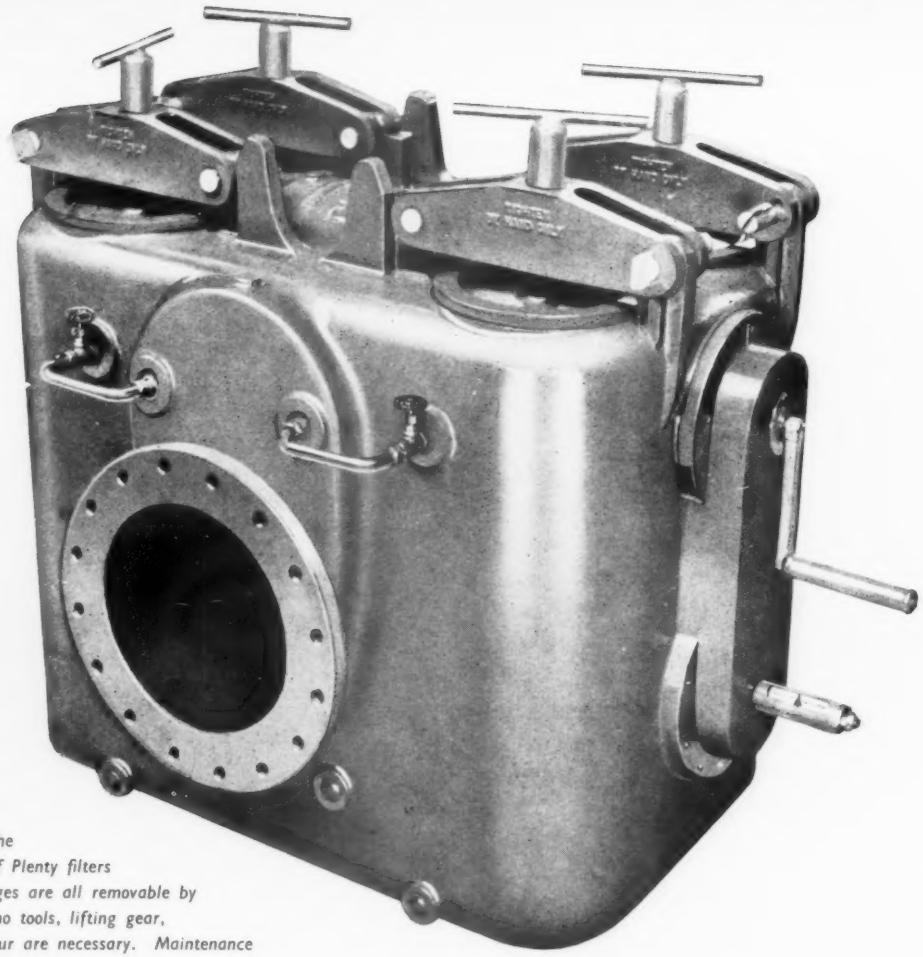

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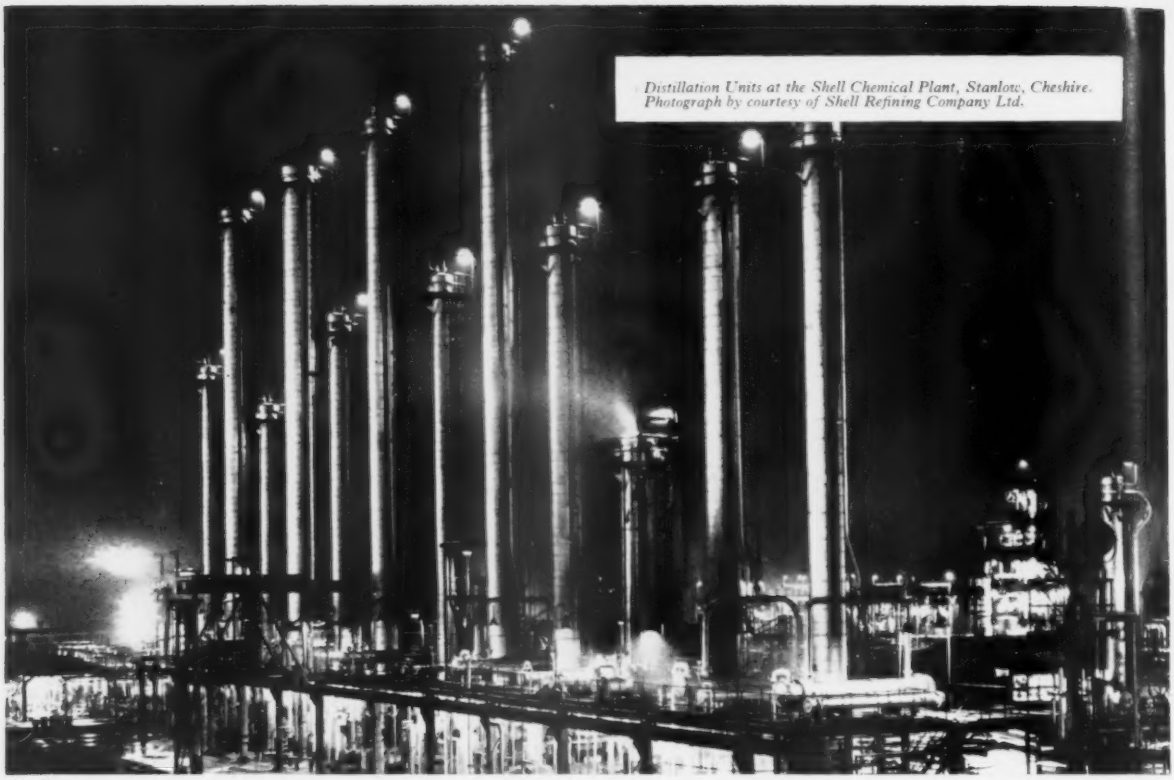

Distillation Units at the Shell Chemical Plant, Stanlow, Cheshire. Photograph by courtesy of Shell Refining Company Ltd.

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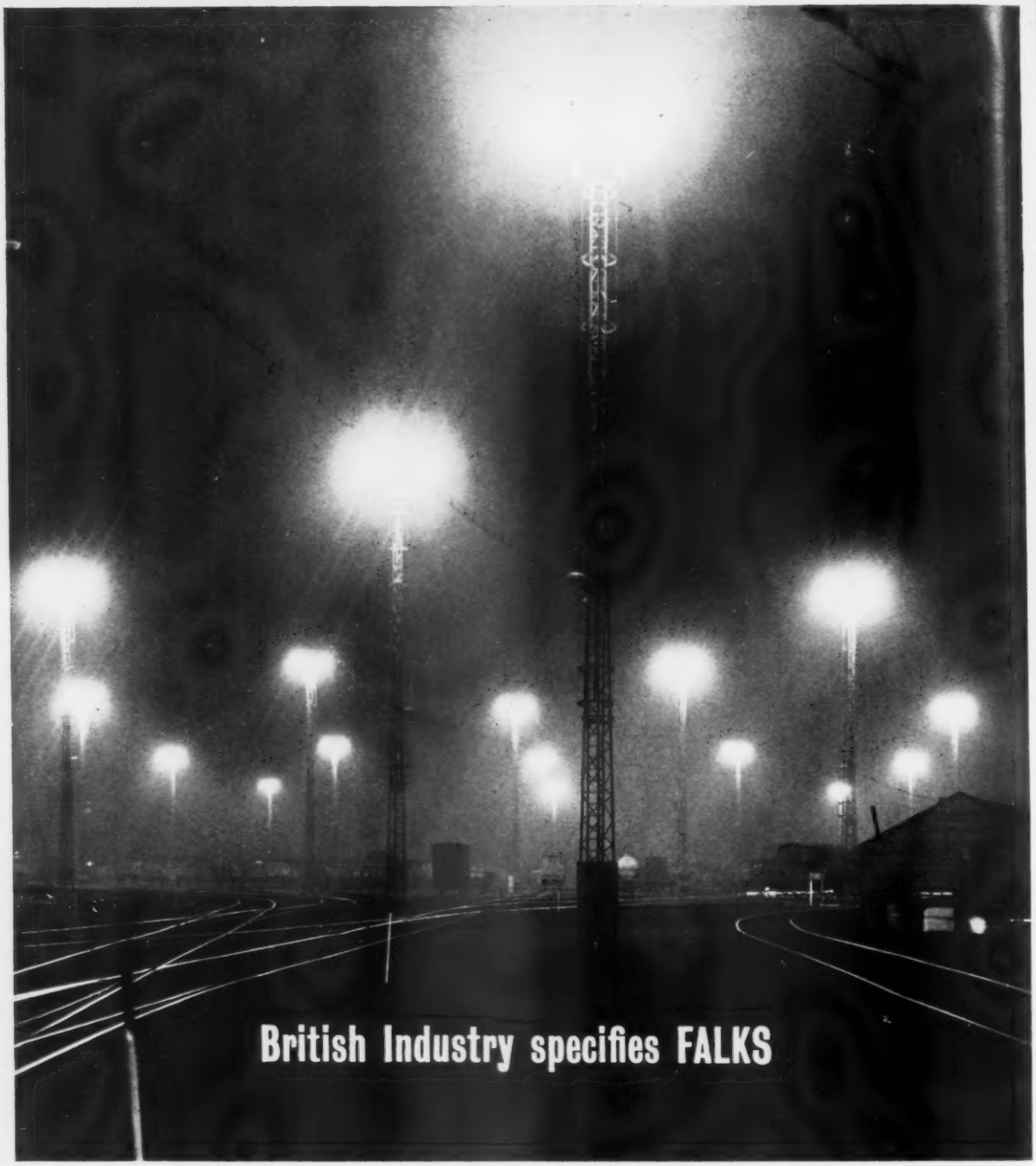

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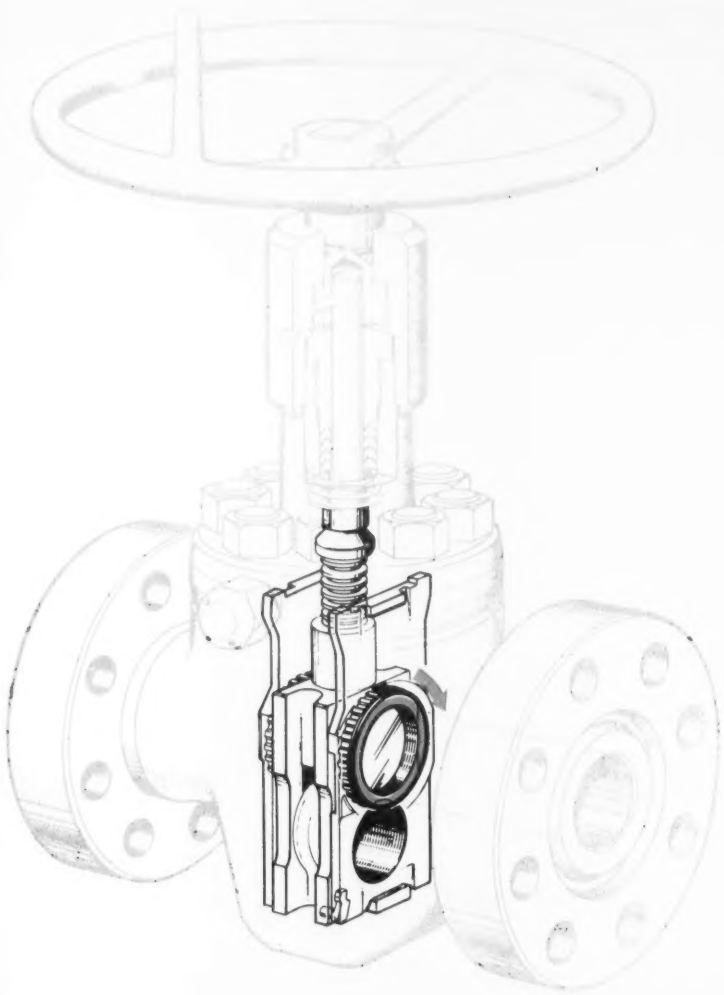


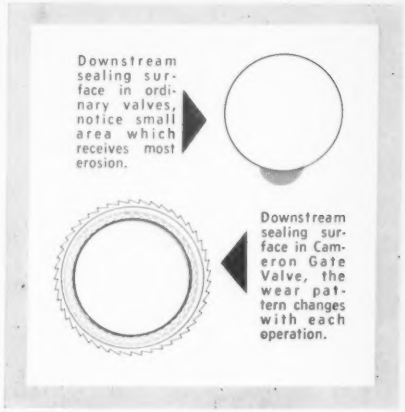
VALVE COST CLUE

The maze of costs connected with the average valve for API service requires more than a clue for a clear understanding, but here is one salient fact applicable to all.

Any API valve serves only one purpose — to open and close the line. The actual cost of the valve is the cost per operating cycle during its useable life multiplied by the number of times it is operated. For a true picture, the average operating cycle cost must include purchase price, all maintenance and repair.

The Cameron Type "F" Gate Valve offers the most operating cycles for the least money — the reason is its exclusive rotating-seat principle, the biggest advancement in API valve design today. With each operation sealing surfaces are changed and wear is spread over the entire contact area. Valve life is extended tremendously.

If you plan, recommend or purchase valve installations for API service you'll want more than a clue to costs — call the nearest Cameron Representative, he can


Downstream sealing surface in ordinary valves, notice small area which receives most erosion.
Downstream sealing surface in Cameron Gate Valve, the wear pattern changes with each operation.

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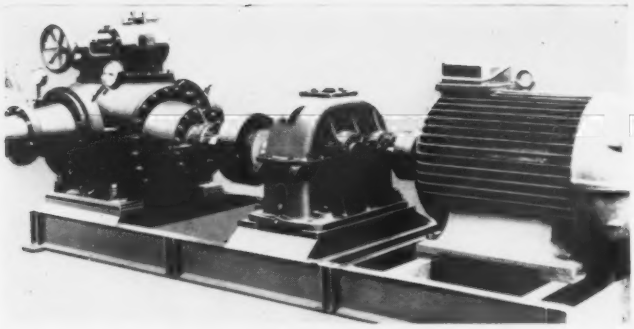

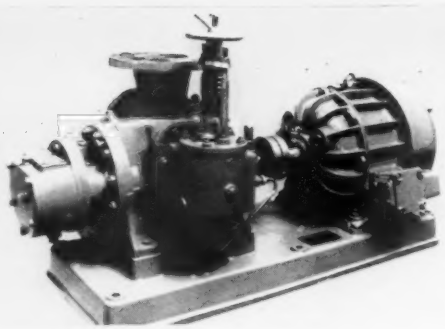

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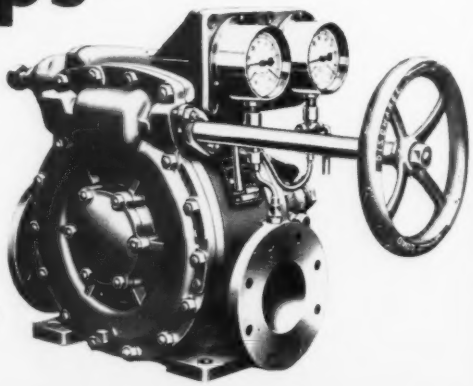
On the right is a Reversing Flow Rotary Displacement Pump for fitting on tank wagons. It is normally driven from the lorry power take-off.



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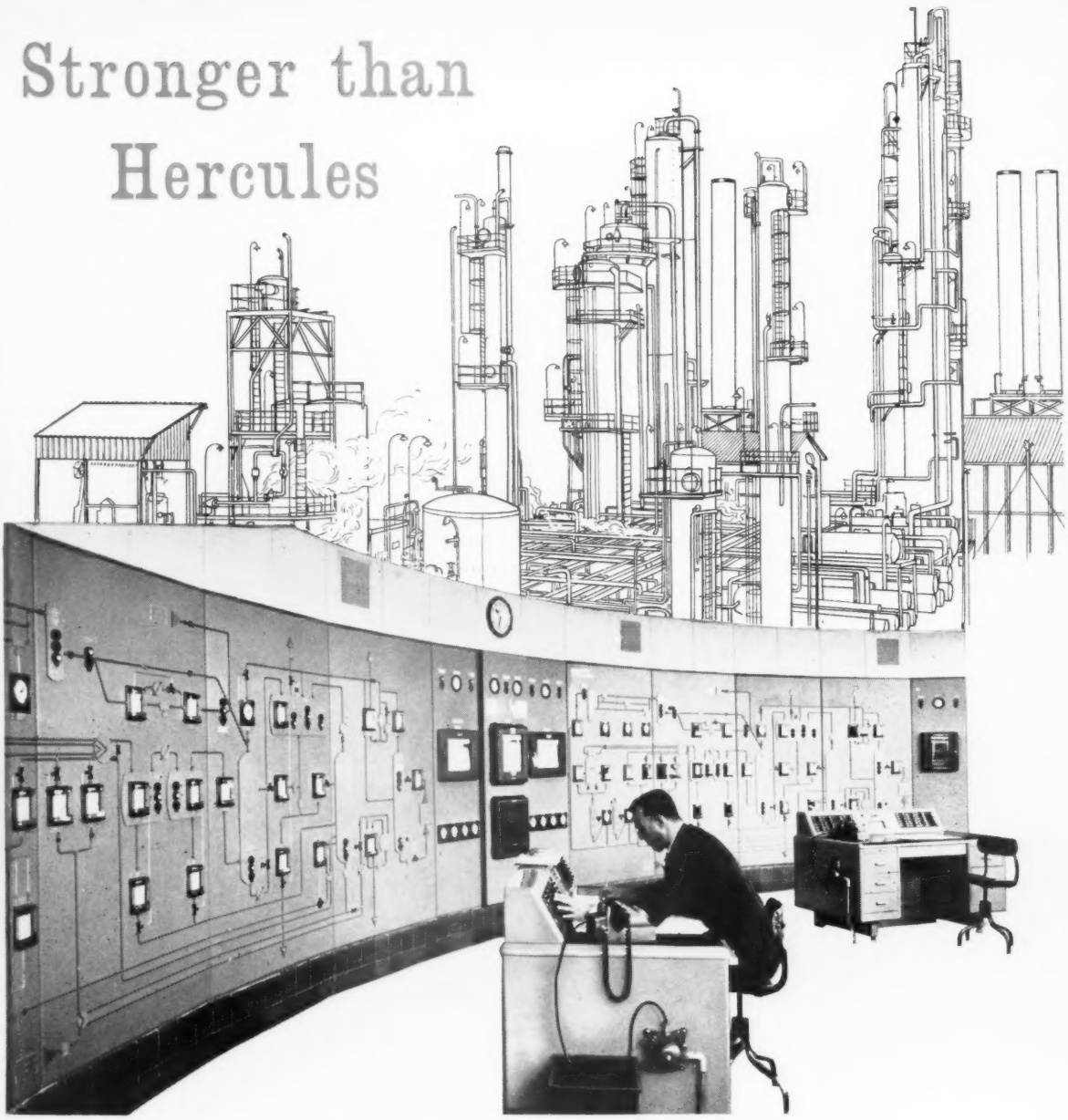

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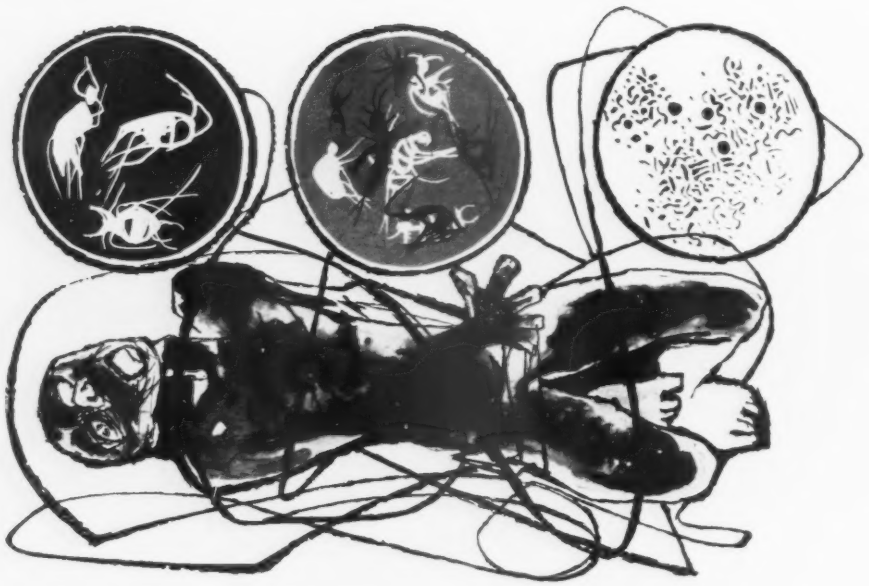

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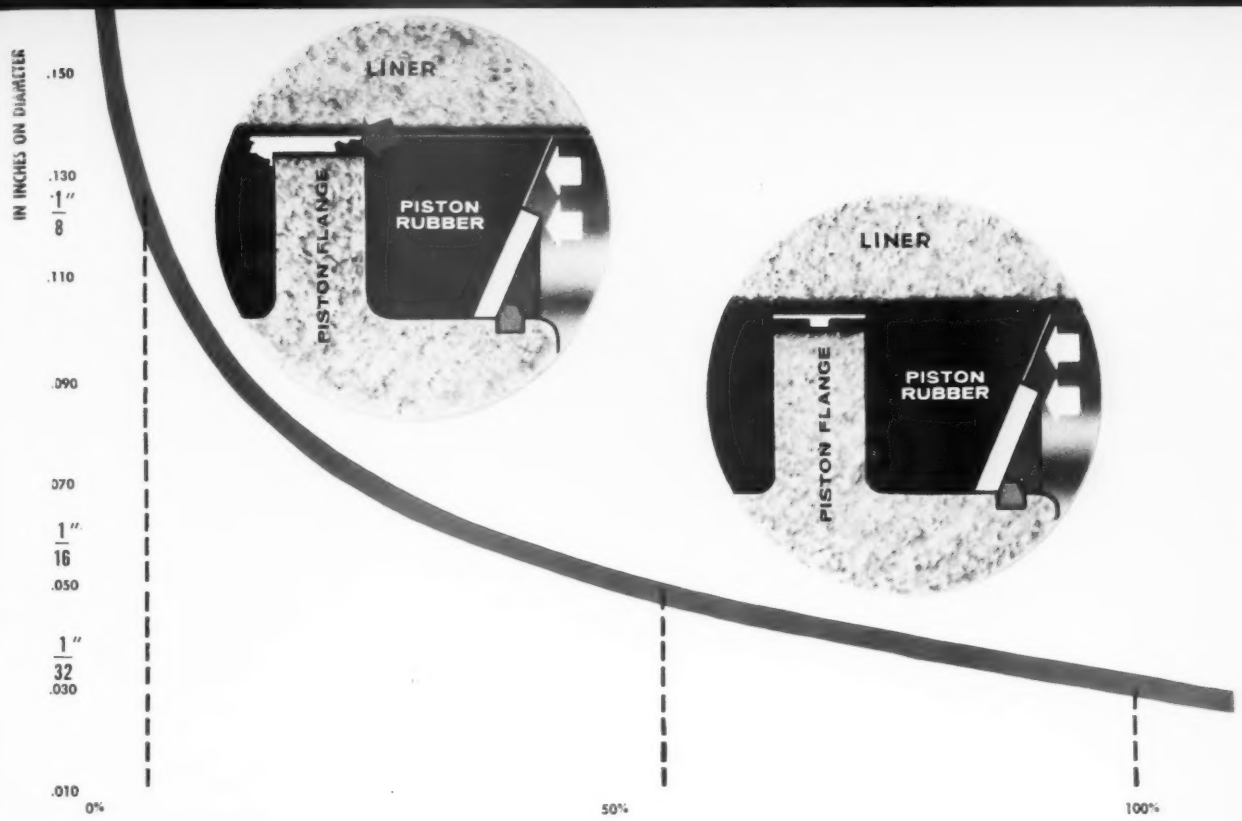

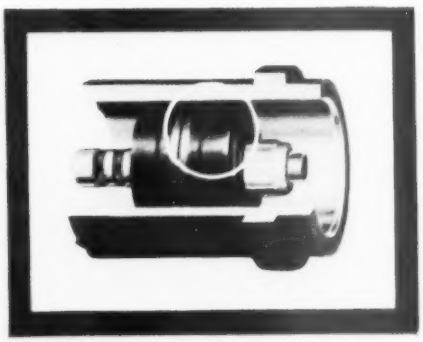

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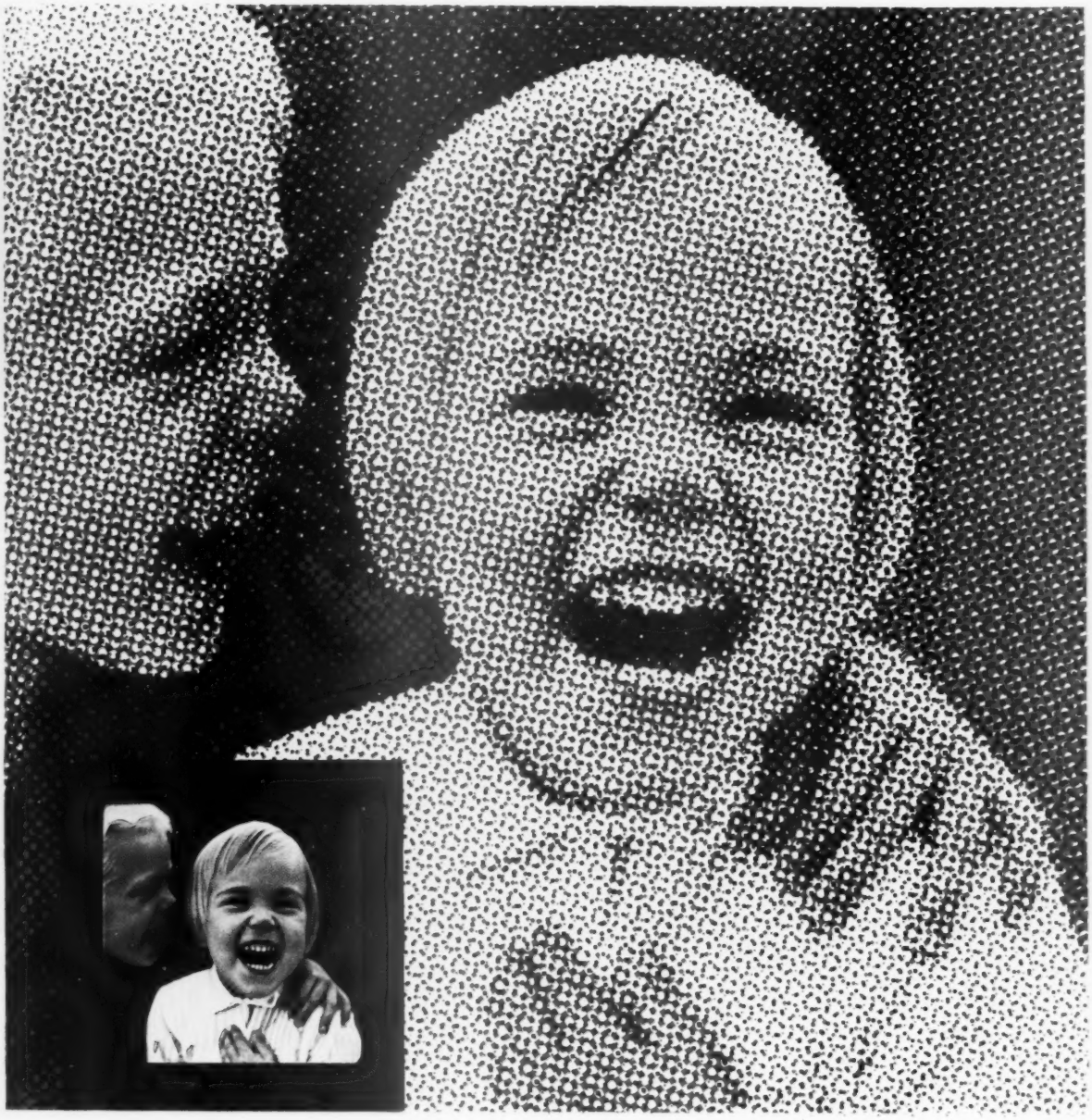

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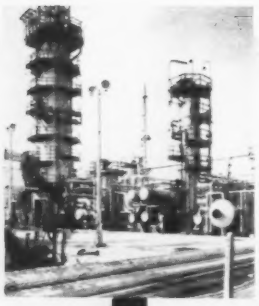

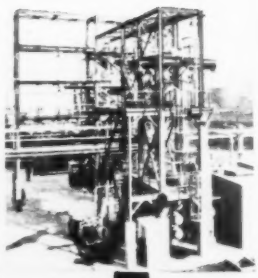

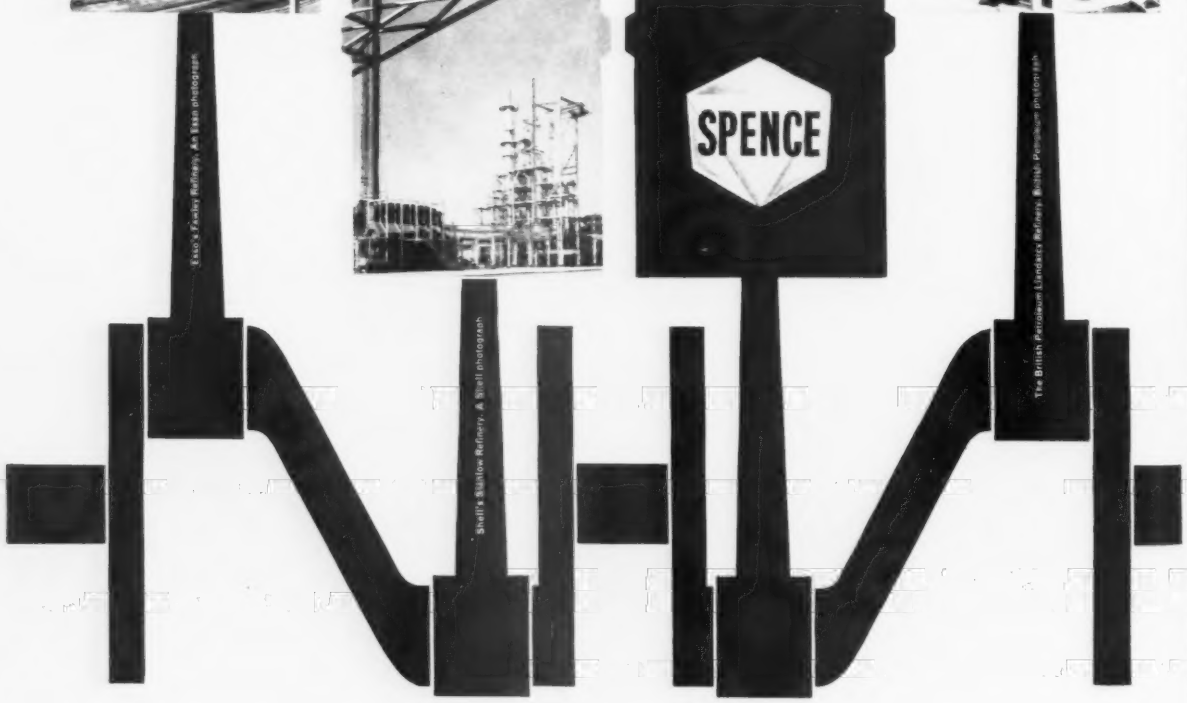
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REVIEW

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Geophysics To-day

By PROFESSOR J. McG. BRUCKSHAW*

On 24 June 1960 the Exploration and Production Group of the Institute held a symposium on Exploration and Production Methods. The first two papers presented at the symposium are published here with the remaining two to be published in a further issue.

It seems to be that the general picture of geophysics to-day is that specially-designed instruments for specific purposes are getting more and more complicated, theories are well established in the majority of cases, and finally there is a large body of observation and experience to support our efforts to derive geological information, or economic significance, from various parts of the earth.

This experience relates to three main methods that have been found most satisfactory in the search for oil: the magnetic method, the gravitational method, and probably the most important, the seismic method.

The Magnetic Method

Before the war, although the magnetic method was an extremely cheap one, it was relatively slow. Geophysicists were confined to the use of instruments that were virtually balanced magnets, and observations were taken every two or three minutes, and although the rate at which the ground could be covered was relatively high, the whole process was a long and tedious one. Since the war, new instruments such as the fluxgate magnetometer developed originally to search for enemy submarines, have been modified, mainly in the direction of greater stability, to form suitable instruments for airborne magnetometry, so that now continuous observations of the magnetic field can be made at a speed of about 120–180 mph, and the detail that it reveals is far greater than with the individual stations of the earlier days. The positioning of the observations relative to the ground was a problem that has been overcome by another wartime invention —the radio wave navigational aids.

Of recent years new instruments are appearing on the horizon and to some extent may have advantages over the fluxgate. The fluxgate does not convey the actual value of the field, but only records variations in it. The proton precession magnetometer, on the other hand, gives the absolute value of the field, without any great set of corrections which are normally associated with accurate and absolute determinations, and as a result of this there is no instrumental drift. This drift is one of the serious defects of the fluxgate magnetometer. The proton precession magnetometer merely involves the measurement of a frequency, but it has the slight disadvantage that it is intermittent in operation. Since the readings can be made about twice a second for most practical purposes it provides a continuous record. A new process is now being introduced for magnetic measurements—the rubidium vapour magnetometer. It has already been developed in a form that is suitable for use in artificial satellites, and so its application to geophysics should not be very far removed. It again depends upon the ultimate measurement of a frequency, and as this frequency is very much higher than the case of the proton magnetometer, the field can be measured with greater ease, and with corresponding or even higher accuracy. For most prospecting purposes, there is no greater requirement for an increase in the sensitivity of these instruments. If you look at an aero-magnetic map you will realize that one of the main problems is to decide what is the anomaly, and what is background or interfering effects and increased sensitivity will not ease the problem. Furthermore, corrections for variations of the magnetic field with time must be applied. If one monitoring station is used to give the main diurnal variation of the magnetic field, one cannot be sure whether this is constant over the large areas that can be covered by a plane in a single day. The problem, in fact, of applying correctly the diurnal variations is one that is virtually still with us, and has not been satisfactorily solved in terms of airborne work. As a general rule, it is included in with regional drift, and possibly partly regional correction and such factors, in its removal.

With the present system, it is possible to measure to the nearest one or two gammas, depending on the general noise

* Imperial College.

level. There would be no grave difficulty in increasing this sensitivity by a factor of 10 or even 100. Rubidium vapour magnometer records have been made in which the noise level is less than a hundredth of a gamma, and the fluxgate is competent to do a corresponding job. But this very great accuracy is never used because no benefit can be derived from it. So to this extent, it would appear that in the range of magnetometry at least we have for the moment reached the maximum instrumental development that is likely to be required. There may be advantages in developing other instruments based on different principles, but there is not likely to be any great demand for increased accuracy.

The Gravitational Method

Similar statements can be made concerning gravity. On land these are instruments that will detect satisfactorily variations in gravity of the order of one or two hundredths of a milligal. Since this corresponds to lifting the instrument up a modest inch or two, it can be seen that any attempt to increase the sensitivity of gravity meters beyond the present existing level would bring in, in a very serious way, the problem of the elevation of the station. Even now, in a large number of surveys it is practically impossible to determine the levels of the stations with sufficient accuracy to permit the full sensitivity to be used, so that by and large the sensitivity that exists in gravity instruments is adequate for present purposes.

There is, however, a rather exciting move in the attempts to measure gravity from moving platforms. The earlier attempts to measure gravity at sea were made in submarines which were submerged to a sufficient depth to reduce movements due to waves on the water, and special pendulum equipment—the Vening Meinesz system for example—was developed to permit reasonably accurate observations under very specialized conditions. But now attempts are being made to make observations from a surface ship. This is a far more severe problem, but nevertheless, by time averaging effects over a suitable period it has been discovered with modern instruments that a sensitivity of 2 milligals can be obtained at sea. Corresponding observations in aircraft, a far more difficult job, tend to suggest that it might be possible to detect changes in gravity with an accuracy of about 10 milligals.

Except in very rare cases, these two sensitivities are somewhat low for prospecting purposes. They are satisfactory for geodetic work. Possibly the 2 milligals sensitivity associated with the gravity meter might be of use for prospecting purposes, but certainly there is no possibility of using the airborne gravity meter. Furthermore, in the air it is necessary to fly a butterfly pattern about and through a point for about half-an-hour, and average the observations. Therefore, from a practical point of view these will not be a very serious competitor with observations on land or even lowering an instrument to the bottom of the sea. Nevertheless, it is a start, and there does appear now to be a reasonable hope that improved accuracy in the measurement of gravity from moving vehicles may be available in the not-too-distant future.

When one considers the treatment to which all these observations are subjected, and the theory upon which this treatment is based, shows again that the limits of gravity and magnetism have almost been reached. The potential theory on which both these methods are based has been known for a long time, and the limitations which are always involved in the interpretation of gravity and magnetic surveys are now fully appreciated.

There have been many ingenious mathematical processes designed to simplify the problem of interpretation as much as possible, but whatever is done with the observations, the final result only contains as much information as was in the original data. And since this original data suffers from the fact that there is an ambiguity in its interpretation, any mathematical derivation from it must suffer from exactly the same defect. There is a tendency to think that because the mathematician has done some very complicated and erudite process on a survey that the results must be of extreme value, but this is not the case. There is a point where the mathematicians might be of greater help. If the solution to a problem is ambiguous, there should be a possibility of inserting into the problem certain conditions that will reduce the ambiguity, and if a suitable number of conditions are included, a unique solution may be obtained. Whether there is a set of conditions that can be imposed in the case of gravity and magnetism that will lead to a unique solution, I cannot say, and it may be that one is asking mathematicians to solve an impossible problem. But if there was a solution, and conditions could in fact be translated into geological terms, geophysicists might be in a position to decide what supplementary data is wanted, whether there is a possibility of obtaining it, and then possibly get part of it—or the whole of it—and so control their interpretation in a more satisfactory manner than the hit-and-miss system that is in operation to-day.

The type of thing one has in mind is this: in a certain area it might well be said that the main gravity anomaly is due to the contrast between light sediments and the heavy basement rock. Suppose the density contrast and the position of the basement at one point were known—maybe it outcrops or a drill has penetrated to a basement—is this sufficient to permit a satisfactory and unique solution? There is a general feeling that it is, but the author has never seen any definite proof that this would in fact lead to a solution. Other possible conditions that could be converted into geological data might be imposed which would enable better use to be made of the data that has already been obtained. There is a similar problem in magnetism.

The Seismic Method

The most important development that has taken place in seismic work is the introduction of magnetic recording, where an explosion is virtually "bottled" so it can be handled under control as often as required, impulses received from the explosion are played back, and submitted to all types of filtering and display methods. The big advantage of this method is first of all that the records can be cleaned up by removing some of the extraneous factors. Such things as the different elevations of the geophones, the depth of the shot, the varying thicknesses of the low velocity zone, and so on can be corrected. Furthermore, the fact can be taken into account that as the geophone increases its distance from the shot point, there is a slight increase in the travel time of the reflection. By removing this spread correction records are obtained that are far easier to correlate. In conjunction with this there are the new methods of display such as the variable area and variable intensity records. These, combined with the magnetic tape system of recording seismic work, provide a very great step forward in the geophysicists' ability to get valuable information out of the survey itself.

There is a trend to carry out all the routine calculations by using digital computers, and the rapidity of these allow interpretations to be made with a variety of different velocity

conditions, and in a relatively short time a number of different interpretations can be compared, contrasted, and considered in conjunction with the other data that may be available. But to do this the records will still have to be read. Now there is a suggestion that the parts of the records that are thought to be interesting are marked on a monitor tape, then, in conjunction with the magnetic tape record itself it is fed into a machine that reads all the times of the peaks on the output from the magnetic record. This information is automatically punched on to cards, and fed into the computing machine which works out the co-ordinates and the dip of the reflecting points and automatically plots them on a diagram. In fact, it almost suggests that the geophysicist is no longer required. This is the general tendency—to reduce routine work to a minimum, to make sure that results are obtained quickly. In many surveys this automation is most essential. In the case of land work, it is normal practice to fire about 10 shots a day, so that it is not a very difficult task to keep up with the interpretation of the records; but when working at sea, it is possible to turn out 10 or more records an hour, and then the problem of interpretation becomes quite severe, and all these machine methods of interpretation are extremely valuable.

One development that provided greater insight into the processes in the seismic method was the introduction of the velocity well logging systems. Before their introduction everyone had a relatively simple picture of what was happening in the ground. Clearly defined boundaries between velocities were imagined, occasionally the layer that was doing the reflecting was made thin and interference was considered from the wave reflected from the top and the bottom of the layer. Some ideas were held about continuous variations of velocity with depth, but the majority of geophysicists were most astonished when they saw the detail in which the velocity varies with depth, as indicated on a velocity well log. In connexion with this, the problem has arisen of what in fact has actually been detected when the geophysicists say "This is a reflection". What does it really mean? To attempt an answer, continuous well logs have been employed for the production of synthetic seismograms. The variations of velocity depicted by the well log are used, either by analogue methods or by direct computation, to determine the nature of the seismogram that should be produced from a predetermined pulse travelling through the ground. This, in comparison with the records taken in the field, has placed the interpretation of reflections on a much sounder basis.

The Development of Geophysical Methods

Although we are making progress in all these developments there is one major complaint: when one compares what is done to-day, with what was done in 1929, it is rather appalling to discover that exactly the same things are being done to-day as were done then. We measured the gravitational field; in the bad old days that beautiful instrument the Eotvos torsion balance was used. Now the gravity meter is used, but we are still measuring exactly the same field. In theory, from the observations of the torsion balance you can compute what should have been observed on the gravity meter, and *vice versa*. In the case of the magnetic method, years ago land instruments were used to measure the vertical or the horizontal component of the earth's magnetic field. Nowadays, we measure the anomaly in the total field, and it is done very much quicker from aeroplanes instead of struggling over the ground. But nevertheless, exactly the same thing is being examined in a slightly different way, and from one set of observations in principle you can get the others.

In 1929 the reflection method was just beginning to appear, refraction had been used in the past. But nowadays reflection surveys and refraction surveys are still carried out. Admittedly, far more sophisticated instruments have been developed —we can detect far weaker signals, we have a far sounder theory on which to base interpretations. But nevertheless, exactly the same things are being used as in the past. But it must not be thought that methods can continue to be improved indefinitely and more be got out of them. There is a limit, and to a very close approximation, the limits have been reached in the case of the magnetic and gravitational methods. The seismic method remains somewhat of a mystery. One of the big problems is the question of signal to noise—the improvement of this ratio permitting weaker and weaker signals to be detected.

Somewhere along the line there is a limit to the smallest signal that can be detected. It may be that this limit is imposed only by practical considerations, and that if an infinite supply of money and time were available even weaker signals could be detected. Alternatively, it may be that theoretical considerations will limit the smallness of the signal that can be obtained. When once this smallest signal has been obtained, we will have reached the limits of the present methods of geophysical prospecting.

This leads to the question as to where are the new ideas coming from. Every geophysicist must at some time have reviewed all the properties that could possibly be employed in the hope of getting something new in the methods of applying physics in the search for oil. But so far nothing has emerged that is extremely satisfactory. New ideas have been produced and have been tried out, but in general they have not competed with the accuracy and the sensitivity of other methods, in particular, of the seismic method. It is the seismic method which is the most important and the most valuable, and the one thing that has to be beaten by any new competitor. But so far nothing has been produced that shows any promise of competing with it.

It should be emphasized that geophysics is not a dead subject. In many ways a lot of very valuable fundamental research is going on, and there is always the prospect that the results will yield some new idea that can be applied for prospecting purposes. But even apart from this, there is still plenty of work to do for the existing methods of geophysics. They have attained a great precision, and a great sophistication, and there is no doubt that they will continue in operation for many years to come, but nevertheless, I am looking forward to the day when somebody comes forward with a sound new idea which can be applied, and from which more information can be obtained than from the present seismic method.

DISCUSSION

Dr A. T. Dennison (*British Petroleum Co. Ltd*): Professor Bruckshaw did not really make me very pessimistic about the future of geophysics. His final point about the difficulty of seeing where we go from here could probably have been applied to the motor car from 1910 onwards, and of course the motor car is still with us. This raises the question that any new idea, any new suggestion that comes up, any new device that is used, does have to compete with these methods which have been developed over a period of about 30 years or so.

Where do we think geophysics, particularly seismic methods, ought to go from here? Towards a cheaper method of doing geophysics to give us about the same accuracy that we have at the moment, or a different method which will give us an improved accuracy? On the accuracy side, it is a little difficult to see how one can make a very big improvement, because already the horizontal variations in the properties of the ground are becoming

quite important. In the reflection method we might like the same resolution that we have, say at 5000 ft, to be obtainable at 15,000 ft. This might be done by using high frequency, but if the high frequency energy can be reflected back above noise level there will be much more trouble with multiple reflections, which are at the moment a hidden factor in most reflection records.

There has been considerable publicity in geophysical literature recently about the increasing cost of geophysics. I am not sure that the cost of geophysics is in fact going up. The costs of a field party may be going up, but the cost of the information obtained has probably not gone up. We must remember here also, certainly on the published figures, that geophysics only costs about 10 per cent of the whole exploration budget, so if economies are required there are other places you could look rather than geophysics.

Professor Bruckshaw: Generally speaking I agree with Dr Dennison. On the question of cost it seems to me that the main problem is not whether we get more information out of the increased cost of geophysics, or whether geophysics in fact only consists of 10 per cent of the total exploration budget. The real fundamental problem as far as petroleum prospecting is concerned is whether we can find oil at a cheap rate. You could spend, for example, twice as much on geophysics, but if it was three times as effective, it would obviously be a very fruitful proposition. The absolute cost is not the significant feature, it is the cost per barrel of oil.

N. L. Falcon (*British Petroleum Co. Ltd*): I think that in almost all that Professor Bruckshaw has said so far he has been thinking about finding out about the structure of the rocks in which the oil is looked for. Perhaps I have misinterpreted this, but I wonder if he could say something about the possibilities of such questions as, is there any salt under here or how many thousand feet of sandstone are there! If geophysics can help to solve that sort of question, and I am sure it can up to a point, it will be doing something which will be extremely important.

Professor Bruckshaw: I think there is a prospect that such problems can be tackled, but when you ask "Is there any salt under here?" I think that at the present moment geophysics does not stand much chance. It may be able to tell of the thickness of sediment, but I doubt whether the geophysicist would ever be willing to say that there was salt, unless he has other information besides the purely physical data. When you identify salt on the surface, you have more than one particular characteristic. As far as geophysics is concerned, we probably have one property; we might have a seismic velocity, this unfortunately is not diagnostic of any particular material; we might have a density contrast, assuming that we could use gravity, but a density difference between the materials is hardly sufficient to identify one of them. Unless we can introduce some sort of physical property that is more diagnostic of the material and use it in some way, then I do not think we will be able to diagnose salt or specify some other rock by geophysical observation only. It may be that the supplementing of geophysical observations by other data, mainly of a geological nature, can show it to be very probable that the salt is there.

F. H. Mann (*British Petroleum Co. Ltd*): Is there no possibility of making use of the attenuation of seismic signals? Professor Bruckshaw has spoken entirely on velocity measurements. Surely the attenuation is also significant, giving another parameter, and a better chance of diagnosing the salt.

Professor Bruckshaw: That is true; hitherto I had been thinking in terms only of time and distance, and I am fully aware of the importance of attenuation measurements. I think that measurements of attenuation in the laboratory are going to give us figures that may assist in identifying materials, and are also going to help us in appreciating the mechanism of this relatively complex process that we are using for our exploration technique.

The combination of the properties of rocks, model experiments, and theory, may ultimately give a far clearer picture of what happens when we let off an explosion, to produce waves travelling out to provide the information on a seismic record. Any individual record shows large numbers of overlapping wave trains but we only use, I suppose, roughly 1 per cent of this information in our interpretation. If we could use more, obviously this would be an advantage, and it is the attenuation that may well be the next step that will emerge and be of value.

P. N. S. O'Brien (*British Petroleum Co. Ltd*): Professor Bruckshaw has done the original work on petroleum magnetic studies and I wonder if he could comment on the extra difficulties which the knowledge of remanence brings into the interpretation of aeromagnetic maps? In particular whether there have been any specific unambiguous cases, where you must bring in remanence of a significantly different direction and significantly greater than the purely induced magnetization.

Would the effect of remanence be concealed in the normal interpretation, which I believe is still largely based on pure induced magnetization; and would there be fairly large errors about which there is no possibility of finding out, purely from the magnetic maps?

On the seismic method, I was wondering whether the fact that there are now programmes for solving dispersion curves for surface waves for many layers will enable us to assemble a large number of dispersion curves to get some rapid, general, idea of the structure and depth of velocity discontinuities, from a very few shots. In principle only one shot and one station are needed for a dispersion curve which gives you the general properties between those two points.

Professor Bruckshaw: It is fairly obvious that when you interpret a magnetic survey over an area where you hope the basement is deep, the prospect of getting properties of rock so that you can really decide what you have done, and compare the interpretation with fact, is very rare indeed. But I can give one specific instance: in a pre-Cambrian area, in a search for titanium, there was a very large negative anomaly, which, had it been buried very deeply, would still have given a very pronounced anomaly of the surface. It was of the order of 2000–3000 gammas at flying height of 200 or 300 metres. Incidentally, this persisted for about 30 km, and was of the order of 2 km wide—quite a pronounced feature. We got a series of rocks from a traverse across the anomaly; we measured the susceptibility and the direction of the permanent magnetism; and on the basis of this, I calculated what the anomaly should have been. It matched the anomaly perfectly in magnitude and shape. Had the structure been covered by sediments, it would have given an anomaly that might have been misinterpreted unless you had taken into account the fact that it was inversely magnetized.

Generally speaking, the interpretation of a magnetic survey is not based on anomalies of the right shape for the particular magnetic inclination in the area. When you make a magnetic interpretation, you probably change the inclination of your models until you find one that will match the observations fairly closely. By so doing you are virtually taking into account the possibility of permanent magnetization in discordant directions.

This question of making an analysis of dispersion to get a reconnaissance of the general condition between the shot and the receiver has been suggested in the past, and I see no reason why in principle it should not be quite useful. But the only way you can decide whether it is going to work or not is to carry out experiments, and I have not seen any experiments of this nature performed.

E. V. Corps (*De Golyer & McNaughton Inc*): One hears a lot about multiple reflections and their general position in seismic survey as being a complete nuisance. Is it not possible that a further study of the generation of these effects might not enable them to be utilized as a useful adjunct to interpretation of the structure which produces them?

Professor Bruckshaw: I am afraid I cannot answer that one. It seems to me that any reflection that we obtain is usually a composite effect of the main reflection coupled with other signals, some of which may be multiple reflections. If you have the velocity well log, I think you could do something about separating out the various reflections.

Dr T. F. Gaskell (*British Petroleum Co. Ltd*): I think Professor Bruckshaw's talk has done what we hoped this Exploration and Production Group would do, that is to bring forth comment—and especially the mixture of comment from geologists and geophysicists—and to bring these two sciences together with production and drilling and the rest of our oilfield and exploration activities. The Geological Society in London caters for the university type of geology, and has rather left the oil people outside. The geophysicists in Europe, in their own association, have looked after themselves. The Institute has, to some extent, looked after production and reservoir engineering, and drilling, but again we have had the feeling from the people who actually find and produce oil, many of them abroad, that the Institute has not been doing quite enough for them. There has been too much emphasis on the marketing and refining side of the industry. I hope this will be a successful annual meeting, and that we shall exchange ideas on our various problems.

Possible Improvements in Drilling

By H. D. FANSHAWE*

The main theme of this paper will cover the economics, design, and potential advantages of a new form of surface equipment for deep-hole rotary drilling. The development of this new equipment is being sponsored by the National Research Development Corporation, and up to the present time has been an exclusively British enterprise.

Sub-Surface Prospects

Over the years a very wide range of unorthodox sub-surface drilling systems have been investigated: pumped explosive charges, flame, rocket exhaust, electric arc, shock waves, and high velocity pellets are some among many. But it is now fairly clear that the future lies with improved mechanical methods of rock attack. All the more immediate prospects involve the various forms of rock-bit—methods of rotating them, or improving their attack or performance. Examples of these methods are the turbo-drill and varieties of air- and mud-driven bottom-hole motors and percussors.

Some new form of hole-making tool may come out of current research, but the range of formation-hardness encountered in deep drilling is so wide that it is hard to believe that diamond and conventional rotary bits will be replaced for all purposes. Again, the continuous removal of cuttings is accepted as an essential feature of a viable system, and there is no real alternative to liquid or gas circulation for achieving it. The realistic conclusion is that all these developments will fall into the category of limited-purpose rotary drilling tools—or perhaps better, circulatory drilling tools, since some might not need rotation.

Current main-stream developments are slim-hole and air drilling, and mud additives and sealed bearings for bit-life. Limiting the forecast to 20 years, these, rather than new tools, are likely to have the greater overall effect on drilling costs. But, be that as it may, the continuous incremental improvement of bit performance has dominated the picture for 60 years; new developments may accelerate this improvement in the next 20 years, and indeed are likely to do so, but no universal or revolutionary change is in prospect, and the bottom-hole tool—let us call it "the bit"—will go on needing replacement in the same old way.

Bit Improvement

What effect will this accelerating bit improvement have on the importance of pipe-handling and portability?

In the past the accent has been on wearing qualities and footage; drilling can usually be speeded by increasing bit weight or rotation speed, but the bad rate-of-exchange in terms of footage lost has restricted penetration rate for normal rotary drilling. Over the years, therefore, bits have tended to last longer hours, and trips to be less frequent. However, only bit and trip costs are halved by the doubling of footage, while the doubling of penetration rate halves drilling time, and drilling time represents far the larger proportion of overall costs.

It is because penetration rate is so much more valuable than footage that research efforts are all now concentrated upon means to apply more horse-power at the bottom of the hole, to improve bearing life, to rotate bits faster, and to improve their mode of attack. No one will be surprised if the next 20 years see footage per bit doubled while the rate of penetration is multiplied by four. This means that bits will last only half as long as they do nowadays, and so round trips will be needed twice as often, and therefore pipe-handling will be twice as important. Portability will become vastly more important too, as each rig will be drilling about twice as many boreholes each year.

Surface Equipment—Economics

Pipe-handling alone designed the rig which drilled Spindletop in 1901. By 1981 portability will have become almost equally important, and the present compromise of a semi-portable mast steepling beyond 150 ft simply will not be acceptable. This is not true in 1960 when a reduction of 10 per cent in overall total costs would hardly be enough to justify radical change to a contract driller. A saving of 15 per cent is probably needed to bring an early end to the block-and-tackle era. Sub-surface techniques must be left out of the account, so these economies must all come from whatever indirect increase in productivity is attainable in present circumstances, and from cuts in prevailing daily costs.

It can be done, but only where drilling is deep enough for a shift crew of three more-expensive men to represent a cut in labour costs, and for the proportion of time now spent in tripping to give scope for an adequate reward from the automation needed to reduce the crew.

Fig 1
The Dowty-Rotol automated drilling rig

Design Principles

Three considerations, then, dictated the design of the new rig. First, a machine needing only supervision

† FNRD Ltd.

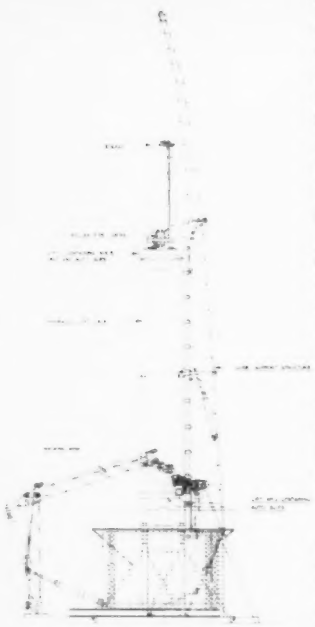

Fig 2

for the operations of drilling, the adding of singles during drilling, and for round trips—thereby releasing the brains and hands available for duties needing flexibility. Secondly, no elaboration which cannot be positively justified, since any increase in depreciation charges or maintenance will cut into the cost advantage gained. Finally, some feature of basic novelty, since this is a field in which most things have been tried, and a peg is needed on which to hang hopes of success.

The peg from which all depends, in the present case, is a very simple one, but it does provide plenty of scope for radical change. A conventional rig has only a single powered lift, the travelling block plus elevators; pulling must therefore stop after every stand for the blocks to run down and take a new grip. If a rig can be provided with two independent lifts, their motions being so arranged that the weight of the string can be transferred from one to the other while moving then pulling can carry on without halting. It is only necessary to mount automatic break-out and spinning mechanisms on the lifts themselves (so that joints can be made or broken while pulling is in progress) and it becomes possible to pull out the whole string of drill pipe in one long, smooth continuous motion.

Dowty-Rotol Automated Rig

Dowty-Rotol Ltd, of Cheltenham, has designed an automated hydraulic rig on these principles and an impression of what it will look like on location is given by Fig 1.

The lower half of what looks like the mast in fact takes only lateral loads; it supports in position a pair of channel section guides for the two lift platforms, upper and lower, each of which carries four rollers and is virtually a trolley on vertical rails. The upper section is simply a light jib to carry sheaves for cat-line and sand-line, and it has no other purpose. There is no engine sub-structure, the power-house being at a distance and connected to the rig by fluid lines only.

The axis of the drill-pipe passes centrally between the twin pairs of main hydraulic jacks. Their feet form a narrow rectangle, the pairs being diagonally opposed. The upper lift is powered by the pair shown extended, the nearly-contracted pair power the lower lift. Each lift has a travel of 19 ft; these travels overlap midway up the guide structure, so that the lifts can move together a short distance when close to one another.

Round Trips

For round trips the lower lift carries slips only; the upper lift carries slips or elevators and also break-out and spinning mechanisms (Fig 2). The process of pulling-out is as follows: when a complete section of drill-pipe has passed up through the rig floor, the lower lift grips below its lower tool-joint, pulls up 15 ft, then hands the string to the upper lift which has come down to meet it mid-way. The whole section of pipe is now projecting through the upper lift. The latter pulls up a further 15 ft, meanwhile breaking and spinning off the projecting joint of pipe. As the upper lift approaches the top of its travel, the lower lift takes a new grip below the next tool-joint, now above the rig floor. The upper lift then runs down to the mid-way station and awaits its next turn to pull, and as it starts down the loose joint of pipe is displaced a distance laterally.

During the lift's instant of waiting at the mid-way station, the joint of pipe is taken away by the transport arm. (The transport arm does have a parallel linkage for shortening it, needed when a joint is to be added to the string as drilling progresses. This is not used, and the linkage is locked throughout round trips.)

When pipe is being pulled, the transport arm swings the joint down into a horizontal position above the pipe-rack. The pipe is then taken by the racking arm, which places it in its appropriate slot in the rack. The rack itself has no moving parts, and could be broken down into unit loads, each portable with its complement of pipe. For running in pipe, the whole process is exactly reversed.

Drilling

For drilling, the slips or elevators are removed from the upper lift and a powered mud swivel, hydraulically driven, is slung from the same attachment points. After drilling down to mid-way, the power swivel transfers itself to the lower lift to complete its stroke. To add a new single, the bit is raised a few feet (or is left on bottom if a core is being taken) and the string is gripped in simple slips in the rig floor. The power swivel is then handed back up to the top of the rig, and the new single introduced between the fully-separated lifts. On this occasion the parallel motion linkage shortens the transport arm appropriately as it swings up into position.

Power Supply and Hydraulic Systems

The power comes from a bank of independent skid-mounted units, these being diesel or other engines direct-coupled to variable-delivery oil pumps. One unit is reserved for the auxiliary hydraulic system, and when drilling is in progress it drives the power swivel; all the other units are manifolded together, to provide the main hydraulic horse-power for pulling pipe or for pumping mud.

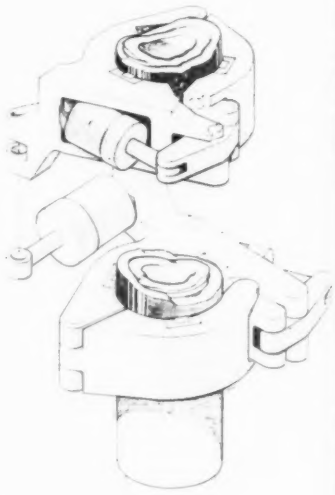

Fig 3

The pressure-exchange type diaphragm slush-pump unit has two or more chambers each divided by a flexible diaphragm; oil is valved to each chamber in turn, its entry expelling the mud. Such a unit is self-contained with its valve gear and needs no rotating parts, nor reciprocating parts other than valves, so is comparatively cheap to maintain.

For pulling out pipe, the main hydraulic power is switched to the two pairs of main jacks alternately. The movements of the lifts are sequenced so that one pulling stroke takes over smoothly from another, keeping the drilling string in continuous and uninterrupted motion, and thereby maintaining a smooth and continuous demand for power. The unloaded lift, whichever it may be at any given moment, is manoeuvred by the auxiliary power unit and hydraulic system, which also powers all other rig mechanisms. The lifts, therefore, do not simply close and separate, repeatedly; each one is accelerated before, and does not decelerate until after the transfer of the weight of the string. Further, although their individual cycles of movement follow an invariable pattern, it is necessary to adapt them for the normal variation in pipe length. There is, therefore, variation in the interlocking of these patterns, and variation in the waiting periods between them.

The pipe-handling mechanisms are required to be fast acting and fully automatic.

Automatic slips operated by a single hydraulic jack are used for pipe handling.

Fig 3 shows an exploded view of the make and break unit, consisting of two grips powered by hydraulic jacks with a third jack to make or break the joint. The whole unit is set into the upper lift (Fig 4).

The spinning mechanism takes its grip during break-out and performs its functions immediately afterwards. It must support the weight of the single at the same time as it is spinning it, and then swing it clear of the axis of the drill-string to prevent interference with the following pipe (Fig 5). This is as complicated a mechanism as any on the rig, and for the record, has a hydraulic motor, three small gripping jacks and two operating jacks, five in all.

All the mechanisms are actuated by hydraulic selector valves, and for round-trips the whole rig is electrically sequence-controlled from a central point. At this control centre the driller has suitable manual overrides in addition to the usual drilling console, and these will be used, for instance, when running casing.

Standard casing elevators and tongs will normally be required, though the pipe-transport and handling-tools could be arranged for use semi-automatically for sizes up to $8\frac{5}{8}$ in. When a very heavy casing string exceeds the design load for a single lift, running is completed using both lifts linked together, with casing slips in the rig floor. Incidentally, it is a great advantage to both the rig designer and to the driller that he can double the lifting capacity of the rig at will; and there are two other advantages in the same category. In emergencies, either lift alone can pull the string; and any one of the motor-pump units can pull the string without difficulty, if only slowly.

Evaluation

Returning to the subject of economics, the necessary valves and control gear must be bought, depreciated, and maintained. Control is not as expensive as it might be, however, because all the operations of drilling are performed by one power swivel, one spinning motor, and 23 double-acting hydraulic jacks, these being the four main jacks, 10 operating jacks and nine small gripping jacks.

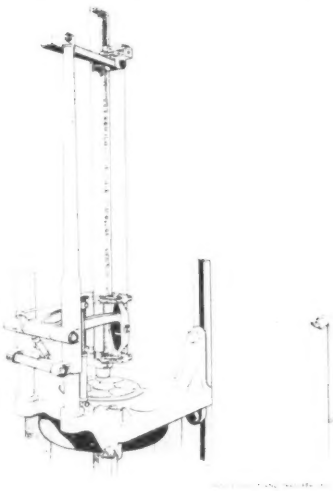

Fig 4

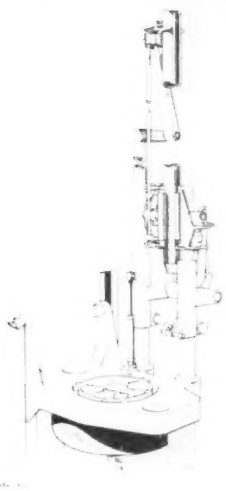

Fig 5

It will be noticed that, outside the power house, the spinning device and power swivel are the only rotating parts, and there are no chains, gears, or belting anywhere; also that conveyors and rack-and-pinion devices, usually the bane of automatic machines, have been avoided. A great deal of complication—and money—can be saved by eliminating the rotary table, blocks and drilling line, drawworks, compound transmission, and other expensive items of conventional practice.

The automated rig that has been illustrated is designed to drill to 8000 ft, and is very small next to the 14 ft + 136 ft + 12 ft of a derrick for pulling "triples" Its dimensions are 14 ft + 47 ft + the 33 ft jib, and they will hardly vary whatever the drilling capacity for which it is designed, whilst the basic degree of elaboration is invariable too. It cannot possibly compete with a small conventional rig, but in larger sizes, and for deep drilling, capital costs are comparable, and maintenance costs compare very favourably.

There are several detailed operations on which time can be saved: no rat-hole or mouse-hole need be drilled; there are no stands of pipe to be broken down, and no drilling line to be strung or moved up. The location needs less levelling, and fluid-line connexion makes layout more flexible.

The major time-saving, however, comes from round tripping. The maximum linear speed is a continuous 4 ft per second, or almost 15,000 ft per hour; but the power normally available will not be sufficient to attain this speed except with a light load or when running in pipe for which only the auxiliary power unit is needed. In general terms, and given the same prime movers as the equivalent conventional rig, the automated rig can complete a round trip to its designed depth in less than one third of the conventional time. For example with 1200 hp effective, an automated rig would complete a round-trip to 16,000 ft in less than three hours.

This comparison becomes less good at half the designed depth, and when only a few hundred feet have to be pulled,

the need to change slip wedges and adjust the spinning mechanism for the drill-collars makes the automated rig slower than a conventional one.

To sum up, the rig that has been described involves the minimum possible degree of automation, but it uses it three times over: first for its true purpose of replacing men rather than tying them to control panels; secondly, to perform operations too fast for manual intervention, and thirdly, to operate mechanisms on moving platforms where a man could not safely go.

Its basic principle is that twin lifts permit continuous pulling, and this principle is used three times over, too: to speed round trips, to reduce the size of the rig, and to allow the use of hydraulics which is only practicable with short-stroke rams.

Economically speaking, it will probably "break even" at about 5000 ft, reach the minimum figure of a 10 per cent overall saving about 8000 ft, and attain the more attractive 15 per cent saving on conventional drilling costs at about 10,000 ft. These figures are necessarily approximate, and apply only to the economic conditions of the contract drilling industry in the U.S.A.

At bottom, this probably explains why the seven-figure sum needed to build and prove a prototype is not forthcoming in the U.K., and current developments are limited to a scale model and some minor practical testing. But, if opinion about the needs of the future should begin to change, then this situation might change too.

DISCUSSION

R. H. W. Hamilton (*Iraq Petroleum Co. Ltd*): It seems to me that the economics of all this, which I suppose is the basis for the reference to the seven-figure sum right at the end, surely depends on the speed of pulling the pipe? If the pipe could be pulled faster, presumably by adding more engines, the economics might be greatly improved. I would like to know if Mr Fanshawe feels there is any possibility of being able to increase the speed, and thereby increase the economies?

H. D. Fanshawe: The trouble here is that you have to go fairly deep before even 15 per cent of a rig's working life is spent doing round trips. That is serious enough, but it means that if you halve your tripping time, you only save 7 per cent of the time the rig spends on location. That, in fact, is less than 7 per cent of the total cost, because you are using the same power, but using it over a shorter period, and also you are not saving on bits, which cost about 20 per cent over all. So you cannot look to your saving on round trips to do more than a certain amount. Equally, the reason that we chose 4 feet per second, 15,000 feet per hour, as our target speed, was because there did not seem much point in going faster. Quite frequently hole conditions do not permit you to go at anything like 4 feet per second. In addition, you soon get into the region of diminishing returns. If you added—in my example, another 1200 hp, this making 2400 hp, you would probably save no more than twenty more minutes on the round trip—possibly less than that.

T. J. F. Armstrong (*Burmah Oil Co. Ltd*): Round tripping from 16,000 feet in three hours or less is something quite revolutionary. However, the rig seems to me, from a brief glance, extremely complicated, and while the crew may have been reduced actually on the derrick floor, no doubt behind the scenes the number of maintenance men has been increased. It would be very interesting to know if such a rig is to be manufactured in the near future. Could Mr Fanshawe give me some idea on that point?

H. D. Fanshawe: We are still waiting for the seven-figure sum which will be needed to build the prototype. I think that it is not likely that one will be built in Britain. The chief reason is that there is no industry in Britain which is capable of taking it on. Neither is there the prospect of obtaining a suitable return from it, since it would be hardly possible to export drilling equipment to the United States where seven out of ten of all the rigs are used.

T. J. F. Armstrong: A few years ago there was an automatic pipe handling rig devised in the United States, using conventional surface equipment. Humble Oil, and Byron Jackson, I believe, worked out the details; it was hydroelectric, with automatic pipehandling, but so far as I know, it was tried out, a film made, and the machine was abandoned.

H. D. Fanshawe: I would answer that one this way: we talked of the savings that could be gained from round trips, and a surprisingly large proportion of those savings are achieved by not stopping. Fundamentally a block and tackle derrick is not suitable for automation. The Humble rig used perhaps one less man in the crew during round trips, but there were crew men all over the rig working detailed mechanisms for which they had the controls. So not only was that machine not suitable for automation, but they were not attempting to use automation in the sense that gives it most of its value.

T. J. F. Armstrong: Laying down the drill pipe in singles continuously will surely increase the thread wear on tool joints. At the moment, we stand back in trebles.

H. D. Fanshawe: That is a moot point. It is certainly true that the automatic rig will make and break three times as many tool joints, but most of the damage to tool joints comes from the stand being set down on the rim of the box, and then dropping into the threads. This will be less with the weight of one than with three joints above it. I think the fixed geometry that you get with a rig without swinging blocks, and the fact that you can effectively weigh the joint of pipe and set it down with a very few excess pounds of weight, and also set it down just right each time with no human errors, should, in fact, greatly reduce the thread wear.

J. F. Smith (*Shell International Petroleum Co. Ltd*): Does not the effectiveness of this particular rig depend on the economics of turbine drilling since you have taken away the rotary table?

H. D. Fanshawe: Turbine drilling, I would say, has now got to the point where such a lot of money has been spent on it that it will find its place; but it will probably do so only as a special-purpose tool. There are occasions when bottom-hole turbines will have to be used all the way, as for instance the Moho project. But I misled you by not making quite clear that the rotary table is replaced by a hydraulic power swivel. No attempt is made, in this research, to develop equipment to alter, or make less flexible in any way, the sub-surface operations. If indeed no power swivel up to the duty is forthcoming, and we cannot design one for what is, in fact, a rather easier duty, then we will have to fit this rig with a rotary table—which is by no means impossible.

H. C. Lack (*Kuwait Oil Co. Ltd*): Could I ask Mr Fanshawe how his rig would deal with the problem of setting 15-in casing?

H. D. Fanshawe: By setting you mean running, in particular? We have handling mechanisms which are designed for handling diameters up to $8\frac{1}{4}$ in in the design that you have seen; these can very easily be adapted for handling sizes up to $8\frac{3}{8}$ in—where you get into difficulties. In fact, stabbing is very much easier because of the fixed geometry, and in sizes up to $8\frac{3}{4}$ in it should very well be possible to develop to the point of stabbing correctly each joint of casing, without difficulty. By virtue of the casing being of large diameter, the spinning mechanism has a greater moment, and quite a number of the turns required could be achieved with the spinning mechanism. If the automatic break-out make-up mechanism is needed, it would have to be used on-the-ratchet, and it is our intention to cross that bridge when we come to it.

The reason that I say this, is that the difficulties we are meeting in deciding how to design this rig, are in defining the economics of making such operations as running the casing automatic—and to what extent they should be automatic. It may well be that even small sizes of casing should be done using casing spider, casing slips in the rig floor, and normal casing tongs. One will have to have a little cat-head unit, for the cat-line and so on; on its other end there is room for a tong line. You could use that for running casing, unless it turned out to be economically worthwhile to spend the money in elaboration to do it in some other way.

H. C. Lack: It seems that the problem of running streamlined casing is rather different from collared casing. I was wondering how you locate the top of the casing for your other mechanism to come in and grip.

H. D. Fanshawe: The question of doing this automatically has not been tackled, but in general terms there is an analogous problem when running in pipe. The tool joint has to be located precisely central between the two break-out tongs, otherwise one is trying to make one half of the joint on itself. The well surveying industry can locate exactly a casing collar from an instrument inside the casing string, and even locate the collars in the outer

casing string of three. It is simply a question of using a black box: we must have a black box for that purpose.

G. F. Wilson (*Burmah Oil Co. Ltd*): I cannot help being very attracted, at least at first sight, by this development because although it is true that tremendous improvements have taken place, and we have got a very highly efficient machine now, it always strikes me the quite intolerable amount of physical work which has to be done by men around a rotary rig. Actually a rotary rig nowadays is a very wasteful machine, because even in the best circumstances fairly deep drilling is common nowadays, and one is very lucky to get 45 per cent per time on bottom, and a very large percentage of this wasted time is in this round tripping.

The speaker has been very careful to underline the degree of economy which does result from that. Apart from the actual direct costs of oil drilling, there is very often the problem of developing a new field, and if production has to be built up to meet refinery and pipeline targets, it becomes a question of the total investment which has to be put into the drilling in order to achieve that target. Rotary rigs nowadays are an extremely expensive amusement; by the time that one has been sent out to the Far East, it will probably have cost £350,000, plus transport, which if you are running several rigs, can easily amount to another £200,000. Therefore any saving which could be achieved in the time of drilling may be reflected back into very considerable capital savings in the development.

What is so interesting with this new rig is to see some breakthrough possible in rotary drilling. A year or two ago it was thought that the turbine drill might be one but it does not appear to be so, although it will have its uses. I wonder if it is possible for people in various major companies to get in contact with this development, because it is impossible to digest this whole thing in the space of an hour, or half an hour. If such people could get in direct touch with those who are working on this, it would be very much easier to see whether this was really a project capable of commercial development, or not. If it were so it would be a sad thing if further development of it has to go outside Britain.

H. D. Fanshawe: First may I say that I would be only too delighted to meet with anyone who thinks there is any prospect of the developing being continued in Britain. But there are two real difficulties here. The first one is that the number of rigs controlled from Britain is comparatively small; it would not support a development programme of the expense which is likely to be involved. But perhaps a more important one is that all the economics of drilling of which I have been speaking refer to a contractor in the U.S.A. who has a lot of service companies at his beck and call, and who contracts to drill a hole in a particular place at a particular time, and gets it done very quickly; also where labour charges are very high. As soon as you go to the Middle East, or anywhere some distance from civilization, there the rig has to wait perhaps for instructions, in particular wait for a new location while the information gathered from the previous hole is being sorted out. Maintenance charges are kept down by using virtually nothing but hydraulic jacks and their control gear, which require no maintenance except, at intervals, their being taken out and replaced by a renovated unit. This works against the economics becoming suitable until the rig has been working in the field for a good many years.

I myself would be enormously encouraged by the thought that development could go forward in Britain, because there is a point which is often forgotten: of the components of a conventional rig, which are very expensive, the compound and the draw-works are the major part. You can buy a lot of hydraulic jacks for the cost of a draw-works and compound. Furthermore, conventional manufacturers do not take very kindly to this sort of new development because it means not only do they have to change what they are making, but they have to start making something which is fundamentally a different sort of engineering.

R. H. W. Hamilton: Is the possibility of a model, or models, of some of the parts practical?

H. D. Fanshawe: There is in existence a $\frac{1}{16}$ scale model, in full detail, with all the services piped up for hydraulic operation. It is rather distorted by being reduced to such a small scale, and it stands about seven feet high. It is not fully up to date, as are the illustrations accompanying this paper. The reason is that it is of little more use now than studying whether you get interference from relative motions. To work it one would have to have the same sequence control as for the full-size machine; developing that sequence control would cost quite a large sum of money, and it is not worth spending that money until it is known that the whole development of the prototype is going forward.

I am quite certain, however, that the model could be made available for exhibition whenever you want.

H. G. Austin (*Iraq Petroleum Co. Ltd*): Might I suggest that there is a basic weakness in the whole design here. As I see it you have your drillpipes being rotated by a hydraulic swivel, and I believe your economic studies showed that at 10,000 feet or more your design of rig would then commence to be attractive. Surely you would have an awful job to design a hydraulic swivel for 10,000 feet of hole, particularly in tough drilling conditions. Surely you would have to cut back to old positive drive ideas, because the slip grip, which was used 40 years ago, had to be superseded on account of the terrific damage done to the drillpipe. That does not seem to be a solution therefore.

H. D. Fanshawe: I believe you are thinking in terms of a mud swivel, plus a power drive applied to the pipe below it? The intention is that your mud swivel is combined with hydraulic motors (though in fact they could equally well be electric motors) which drive on to a pinion, through which the mud passes, and that pinion could be 30 inches in diameter. For a very deep hole, as much as 250 hp or more applied at that power swivel might be needed. But 250 hp of hydraulic motors is comparatively small. You probably could do it conveniently with three, and each of these could sit on a two-foot square table. So it is certainly a reasonable proposition for that capacity.

F. H. Mann (*British Petroleum Co. Ltd*): There seems a fundamental contradiction between deep hole drilling, and the limitations of the size of casing that can be handled. Is the surface hole and conductor pipe to be set by a separate rig, and then this rig moved in, or is it intended to handle it in some other manner?

H. D. Fanshawe: I am misleading you in saying that the rig cannot handle pipe larger than $8\frac{5}{8}$ in. This rig, like any other, is basically a lifting means, and when you want to handle larger sizes of pipe, you take out your slip bowl, and put in its place ordinary casing handling tools. One lift, the lower one because it is the convenient one, can run casing up to a certain weight, with casing spider and slips mounted in the rig floor. It is only when you get to very great weights—for which the rig has a designed capacity much less than its conventional equivalent, because it can use two lifts at once—that you then hitch the two lifts together. It will still operate on large sizes of casing, push and pull, start and stop, just as is done at present; the difficulty being that there can only be 15 feet of stroke at one time.

F. H. Mann: It means then that casing can be automatically handled up to $8\frac{5}{8}$ in, or semi-automatically at greater diameters, but the real limitation is just weight?

H. D. Fanshawe: Casing can be handled semi-automatically—and by that I mean that the racking arm is used, the transport arm, and the casing taken in over the top of the upper lift—if it proved economically worth while, and for sizes up to $8\frac{5}{8}$ in. With larger sizes you would not attempt to do so. The rig is designed to make automatic only those operations which occur time and time again; casing happens once per hole. I do not think it would work out that it was economically worthwhile to put in any elaborate mechanism for making that process fully automatic.

* * *

ENGINE TEST METHODS FOR RATING FUELS

The second edition of the handbook on *Engine Test Methods for Rating Fuels* has now been published by the Institute as Part II of IP Standards. Its 134 pages contain details of eight methods one of which, the extended research method (IP 172/60T), is completely new. Its use is to determine octane numbers over 100 by the research method. Of the other seven methods, five relate to the knock rating of spark ignition fuels and two to the determination of ignition quality of diesel fuels.

There has been considerable revision in all the previous methods. The book also contains details regarding reference materials and blending accessories and instruments for the maintenance of CFR engines.

Copies, price 30*s* each (25*s* to IP members) post free, can be ordered from the Institute.

Around the Branches

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Trinidad Branch

At the meeting of the Trinidad Branch held on 27 July, E. G. Marsden of Texaco Trinidad Inc presented a paper on Refinery Nomenclature and Processes which was of particular interest and benefit to those on the fields side and those less familiar with modern refinery practices. Mr Marsden's talk covered a wide field commencing with the early type of shell still distillation units, and culminating with the modern refinery with its many distinct and separate processes aimed at achieving maximum economic yield of the various products that may be obtained from crude oil. Brief descriptions were given of the processes involved in topping, Dubbs, cat-cracking, isomerization and polymerization, reforming, platforming, Rexforming, visbreaking, hydro-treating, etc. It was amply shown how modern refinery practice had made tremendous progress since the early days after the Drake well, as a result of keen competition and demand for improved products. The meeting terminated with a vote of thanks proposed by L. de Verteuil.

The 194th general meeting was an innovation in the form of a buffet supper at the Royal Hotel, San Fernando, on the evening of 2 September. Many wives and guests were present on this informal occasion, and at the conclusion of the supper P. E. T. O'Connor, J. Ironside, and L. J. Shrubsall, as guest speakers, entertained those present with lively and amusing reminiscences of the Trinidad oil industry in the 1920's. Mr O'Connor dealt with his experiences as a geologist, Messrs Ironside and Shrubsall as refinery and marketing personnel. At the conclusion of the talks members were further entertained from the audience by Mr Brackenreed, a drilling engineer and a contemporary of Mr O'Connor at the start of the Kern Field at Guapo. Members were duly impressed by the graphic descriptions of living and working conditions in those far-off days of no roads, minimum facilities, and no income tax. The meeting officially concluded with a vote of thanks proposed by A. Curlet, although further reminiscences continued afterwards at the neighbouring bar.

London Branch

"Industrial Market Research" was the subject of the lecture to the London Branch which was held on 20 September.

The author, W. R. Everard, of Laporte Industries Ltd, commenced by pointing out that industrial market research could not be defined without reference to the other types of research from which it drew its techniques.

These included consumer and operational research, which were then explained. It was said that given that industrial market research was the endeavour to study in a logical fashion the problems faced by companies in purchasing, selling, and in product development, then the following major problems arose. First, to insist upon getting the given problem into focus, and upon securing an adequate briefing. Second, to ensure that reports were accepted because of their contribution to the problem, and not because they meet preconceived ideas. Third, to select the most economical technique of tackling the problem, and to avoid using the same technique in handling problems which were inherently different in nature. Lastly, to secure the correct quantity of factual information and to place it in the right order. The industrial market researcher had constantly to use his sources with an eye on time and expenditure.

The three principal types of technique employed in such research were sampling methods, correlation techniques, and the analysis of time series. The methods employed would depend upon both the ingenuity of the researcher and upon his experience of the field concerned.

Examples were given of the use of a correlation technique in the study of titanium di-oxide demand, and in the use of sampling on a large scale in the case of a European study of the markets for hand and portable power tools.

The organization of industrial market research in the U.K. was described: the industrial discussion groups, advertising agencies, management consultants, and specialist research firms.

It was said that in future increasing reliance would probably be placed upon the use of mathematical techniques using computers. These mathematical studies might be extended into the financial operations of companies in order to provide a more flexible financial approach than was sometimes possible with accountancy methods. Improvements in the available sources of data were overdue, and it was thought that industrial market research might become of increasing value as a field of management training.

Essex Branch Brains Trust

A "Brains Trust" meeting on the subject of "The Use of Automotive Fuels and Lubricants" is to be held by the Essex Branch at the Bull Hotel, Pitsea, on 14 December at 7.30 p.m.

Those taking part will be:

Chairman: C. G. Tressider, A.M.I.Mech.E., M.S.A.E., F.Inst.Pet. (*Mobil Oil Co. Ltd*);

Members: L. A. G. Cooper (*Castrol Ltd*); I. Glover (*International Lubrizol Laboratories*); C. L. Goodacre, M.S.A.E., A.R.Ae.S., A.F.Inst.Pet. (*Associated Ethyl Co. Ltd*); J. R. Lodwick, B.Sc., A.R.I.C., A.F.Inst.Pet. (*BP Research Centre*).

Personal Notes

J. Blake Middleton, F.Inst.Pet., who will retire early next year on achieving 40 years' service with the international group of Mobil Companies, has resigned his directorship of Mobil Oil Company Ltd. As the director in charge of manufacturing since 1950, Mr Blake Middleton was primarily responsible for the building and operation of the Coryton refinery.

B. R. Fraser

To fill the resulting vacancy, **B. R. Fraser,** B.Sc., F.inst.Pet., has been elected a director and will be in charge of manufacturing. Formerly general manager of Burmah Oil Company's Digboi refinery in Assam, and from 1954 to January 1960 manager of the Coryton refinery, Mr Fraser was until his new appointment the manager of Mobil's manufacturing department.

Laurence C. Bergquist has been appointed executive vice-president of Iricon Agency Ltd, and general manager in London, succeeding **Arthur H. Elliott,** who is retiring from these posts.

In his new position Mr Bergquist will also hold directorships on the boards of Iranian Oil Participants Ltd and Iranian Oil Services Ltd. Mr Elliott becomes a consultant to Iricon.

Prior to joining the Agency in 1956 Mr Bergquist served 25 years in overseas operations with Standard-Vacuum Oil Company, for the most part in southeast Asia. He holds a B.Sc. degree in industrial engineering from the University of North Dakota and an M.A. degree in political science from Columbia University.

H. W. Rocke, managing director of Mobil Oil Company, made a presentation to **H. R. Cobb** (right), purchasing agent, when he retired from the Company in September after 50 years service. Well known throughout the oil industry for his work with the Lubricating Oil Pool during the 1939–45 war, Harold Cobb joined Mobil as a junior in 1910. He returned to Mobil after the war and worked in various sales departments before being appointed assistant to the late H. Holliday, then managing director of the Company. He worked with Mr Holliday on the Lubricating Oil Pool and later joined the Purchasing Department, becoming purchasing agent in 1950.

J. G. Dawson, B.Sc., M.I.Mech.E., director of engineering, F. Perkins Ltd, has been appointed chairman of council of the British Internal Combustion Engine Research Association. **S. J. Wood** becomes vice-chairman.

Dr R. H. Griffith, F.C.S., F.Inst.F., has retired from his post as director of research at the Gas Council's London Research Station.

Educated at Magdalen College, Oxford, where he obtained a D.Phil., he joined the research laboratory of the Gas Light and Coke Company in 1925, and during the ensuing 35 years has built up a world-wide reputation in the field of catalysis.

In 1945 he was appointed senior research chemist to the Gas Light and Coke Company, a position he continued to hold with the North Thames Gas Board after nationalization. He was appointed controller of research of the Board and director of the London Research Station of the Gas Council in 1952.

C. E. H. Verity

The Gas Council are to review their research activities shortly, and for the time being Mr Hopton, senior research chemist, will be responsible for research at the Fulham laboratories of the London Research Station.

C. E. H. Verity, managing director of Foster Wheeler Ltd, has been elected a director of the parent Company, Foster Wheeler Corp of New York.

A. S. Bridgewater, A.M.Inst.Pet., is one of five additions to the board of Foster Wheeler Ltd. Others are **R. L. J. Hayden, C. J. Geiss, J. F. G. Arman,** and **J. McLean.**

J. E. Lytle, B.Sc., M.I.Mech.E., M.A.S.M.E., F.Inst.Pet., previously deputy to the vice-president—contract operations and director of engineering, of Kellogg International Corp, is succeeded in the latter position by **J. M. Wentworth,** presently chief project manager.

F. J. King, M.B.E., D.S.C., M.I.Mech.E., M.I.Mar.E., M.Inst.Pet., will be promoted to chief project manager.

John McVean Luard, general manager for exploration, The British Petroleum Co. Ltd, has been appointed a director of BP Exploration Co. Ltd.

John Moffat, BP general manager for refining, becomes director of BP Refinery (Llandarcy) Ltd, BP Refinery (Kent) Ltd, and BP Refinery (Grangemouth) Ltd.

The Distillers Company Ltd announces the formation of a Development Division in its Industrial Group under **Dr H. M. Stanley** as controller. The following appointments have also been made: **C. E. Hollis,** manager, Central Research Department; **G. P. Armstrong,** manager, Licensing Department; **Dr H. W. Ashton,** manager, Planning Department.

J. R. Moore

J. R. Moore, M.I. Prod.E., A.M.Inst.Pet., manager of the Fisher Governor Company at the Rochester factory of the Elliott-Automation Group, and chairman of the IP South-Eastern Branch, has been appointed assistant general manager of the Elliott Valve Group of Companies.

A. L. Kennedy, who has been works manager at the Triangle Valve Company Ltd for the past 12 years, has been appointed works director.

IP EXPLORATION AND PRODUCTION GROUP

The remaining meetings of the IP Exploration and Production Group will be as follows.

24 *November* **In-Situ Combustion**, H. J. Tadema (NIM).

21 *February* **Petroleum Exploration In Peru**, A. J. Knights (Lobitus Oilfields Ltd).

23 *March* **Development of the South-East Kuwait Oilfield**, A. F. Fox (Kuwait Oil Co. Ltd).

A Group symposium on "Why are Oil Reserves Continually Growing?" will be held on 23 June 1961. The four papers to be presented on this theme will deal respectively with the geological, geophysical, production engineering, and drilling aspects of the question.

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ASTM ANNUAL MEETING 1960

Committee D-2

Committee D-2 on Petroleum Products and Lubricants announced the organization of a new Co-ordinating Division on Nuclear Problems at its meeting during the ASTM Annual Meeting in Atlantic City, N.J., on 26 June to 1 July 1960. Chairman of the new division is L. P. Manley, Socony Mobil Oil Co. Inc., Paulsboro, N.J. The division mapped a programme of activity and assigned areas of responsibility for liaison and technical surveillance as one of its early activities. An open forum is planned for the ASTM Annual Meeting in June 1961.

Committee D-2 will look into possible revisions to ASTM specifications for burner fuel oils—ASTM D-396 which has remained unchanged since 1948. Changes under consideration would provide a sharper delineation between No 1 and No 2 fuel oils to narrow the range for acceptable fuels for No 2 grade. Many feel that these changes would result in less adjustments to existing fuel oil burners and would permit the owner to maintain his burner at top operating efficiency more easily.

The Committee stage two symposia during the coming year: on 11 October 1960, a symposium on Non-Newtonian Viscometry was held in the Mayflower Hotel, Washington, D.C, and in February 1961, a symposium on Research on Gasoline will be held at the Benjamin Franklin Hotel, Philadelphia, Pa. The latter symposium may affect specifications on gasoline, and will discuss requirements, anti-knock measurement, road octane number, rumble-thud, and other abnormal combustion effects.

Protein-rich food for human beings might result from the work of a new task group on light hydrocarbons formed to consider the development of methods of test and specifications for hydrocarbon solvents to extract the oils from seed cakes and other food products.

Harold M. Smith, U.S. Bureau of Mines, was re-elected chairman of the committee for a two-year term. T. B. Rendel, Shell Oil Co. Inc, was elected to succeed R. C. Alden, who retired as first vice-chairman. W. K. Simpson, General Motors Corp, and W. T. Gunn, API, were re-elected second vice-chairman and secretary, respectively. R. R. Wright, API, was elected assistant secretary.

The mid-winter meeting will be held 5-10 February 1961, in Philadelphia, jointly with Committee D-16 on Industrial Aromatic Hydrocarbons and Related Materials.

Committee D-16

Industrial aromatic hydrocarbons continued to receive concentrated attention by ASTM Technical Committee D-16 on Industrial Aromatic Hydrocarbons and Related Materials at the ASTM Annual Meeting. Activities were directed toward two major objectives—to incorporate new knowledge about coal and petroleum chemicals into the framework of the standard products of concern to the industrial consumer; and to disseminate technological information on new industrial materials.

A significant contribution has been made by the committee's work in creating a broader understanding of the problems in commercial production, testing, and distribution of high quality and industrial grades of benzene, toluene, and xylenes. Differences in consumer attitudes on quality requirements have been lessened so that it is now possible to consolidate a number of grades that need be specified. This provides real savings to the ultimate consumer.

A protracted study of means determining relative amounts of xylene isomers has resulted in publication of a proposed standard method using the infra-red technique. Work is continuing on development of a standard gas-liquid chromatographic procedure replacing the infra-red approach. Additional tables for calculation of volume and weight of mixed xylenes are projected for publication as part of the Tentative Tables D 1555-58T.

New standardization areas under development include specifications for refined phenol and methods for phenol assay. Considerable effort is nearing completion in the development of methods for styrene monomer and polymer. Work on tar acid test methods for determination of oil and naphthalene, distillation range, specific gravity, water content, and solidification point of tar acids are being drafted.

Shell Research Institute in Germany

One of the most revolutionary developments in the locating of oil refineries in recent years has been the establishment of large-scale plants in inland centres of consumption (particularly fuel oil consumption) in Europe, far from any continental port, but connected with such ports by large-diameter crude oil pipelines. One of the latest of such refineries is the recently-opened Ruhr refinery at Godorf, near Cologne, owned by the Royal Dutch Shell Group and described elsewhere in this issue.

In line with this new development, the first petroleum research institute to be established in Western Germany by Shell has been built at Birlinghoven, near Godorf. In April 1959 the Shell Grundlagenforschung-GmbH (Organization for Fundamental Research Ltd) was formed as a 100 per cent subsidiary of the Deutsche Shell AG to administer the projected research establishment.

It was arranged that the institute was to be housed initially in Schloss Birlinghoven, and after a total land area of some 27 acres had been purchased for the permanent establishment, work was begun on the reconstruction of the Schloss in July 1959. About four months later the first laboratories were available for research to commence. In the second phase of the construction a new laboratory building will be erected on the site already purchased, probably during 1961–2. When it is completed the present laboratories will be moved from the Schloss and its outbuildings into the new facilities.

As is indicated by the name of the company, the work carried out at Birlinghoven is not in the sphere of applied research, but concerns the discovery and development of new reactions.

The institute consists of 15 fully-furnished "preparative" laboratories, each occupied by teams of one chemist and three or four technicians or assistants. These are supported by a number of service departments, comprising the analytical and physico-chemical sections, workshops, glass-blowing facilities, and material and chemical stores, as well as a technical library.

Great importance was given to extensive safety precautions in the layout of the laboratories. Each laboratory has two exits, independent ventilation and air-extraction systems, fume cupboards equipped with safety glass, splinter-protection devices, and several types of CO_2 fire extinguishers. In addition to the latter appliances, an automatic CO_2 fire-fighting installation, which in the case of danger automatically releases an acoustic alarm system, is used as an additional precaution whenever reactions are left on during the night.

The basic services available at Birlinghoven were inadequate for the operation of a research laboratory. The old transformer station had to be replaced by a new one in which three 11 kV feeds can achieve a total output of 1500 kVA. Gas supplies were assured by laying a line from Birlinghoven to Neiderpleis to connect with the gas main of Rheinische Energie AG (Rhenag). To obtain the considerable quantities of water that would be required, a new connexion to the public water mains was installed, and the problem of the disposal of waste water was solved in collaboration with the local authorities.

The decision to establish the Birlinghoven Research Institute as an establishment entirely devoted to fundamental research was taken, in the words of its manager Prof. Dr Friedhelm Korte, for the reason that: "If it is intended to create the most favourable conditions for successful research in such an institute it has to be situated within the sphere of influence of the kind of academic research which—also internationally—plays an outstanding part in this field. Only in this way will it eventually be possible, on the basis of a permanent and confident exchange of ideas with universities and learned societies, to bring the work of the institute into line with the aims and efforts of these academic institutions."

With the establishment of Birlinghoven, the number of Shell research laboratories in the world has risen to 16. Eight of these are in the U.S.A, four in Britain, three in the Netherlands, and now one in Western Germany. The research carried out at these laboratories extends over all the fields in which the 500 subsidiaries of the group are active.

HYDROCARBONS IN BLAST FURNACES

Esso Research and Engineering Co. has been conducting a concentrated programme for more than two years which promises to result in one of the most important iron manufacturing developments in the past 20 years. The project is aimed at proving the feasibility of a 75-year-old iron-making idea. The concept that has now been developed by scientific studies and experiments is that hydrocarbons, particularly heavy oil of high heat content, can be successfully injected into the bottom of blast furnaces and, in many circumstances, can increase capacity and decrease costs of "hot metal" production.

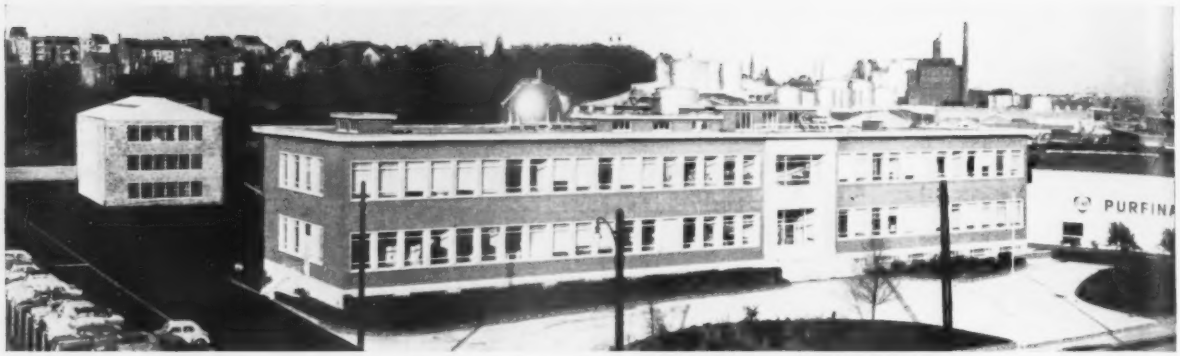
Esso Research investigated the practicality of the idea, and in an intensive programme solved the complex problems involved and developed an injection and control system which makes the idea usable. The scientific principles underlying the new development involve taking advantage of the chemical properties of oil as well as its heat-producing ability.

Blast furnaces produce pig iron in hot liquid form by extracting oxygen from iron oxide. The blast furnace is actually more of a chemical plant than a furnace, and oil (containing hydrogen) contributes additional "reducing" gas to speed the reduction of ore into iron.

Coke, iron ore, and limestone are to-day fed into the top and hot air into the bottom of blast furnaces where temperatures reach some 3500° F. With the new fuelling method, oil can be injected along with the heated air. The petroleum fuel serves as part of the source of heat and of the "reducing" gases.

One of the most important Esso Research developments for this application of oil is the fuel injection and control system. Since blast furnaces "stay on the line" for as long as eight continuous years, this system must be so designed that it can be installed into large furnaces without any interruption in the use of the furnace. In arriving at a suitable system, the company designed, built, and operated a pilot plant simulating that part of a blast furnace most critical to oil injection. A unit of this system was later installed and tested in a hot operating large-scale furnace with complete success.

Some U.S. and European steel firms had been working along similar lines with natural gas injection, and there are reports that some Russian blast furnaces are using natural gas to increase their iron-making capacity. The Esso Research study is still continuing on experimental and full-scale furnaces to get more accurate data on capacity increase and saving in operating costs.



Petrofina research centre at Brussels, with the new pilot plant building on the left

Petroleum Research in Belgium

THE WORK OF LABOFINA SA

All research work for the "Petrofina" SA Group is concentrated in its wholly-owned subsidiary, Labofina SA, a company formed in 1954 to continue on a larger scale work which had originally been carried out to a limited extent in a small laboratory in the Company's main office building in Brussels. The present research centre is on the outskirts of Brussels and, out of a total area of 12,000 square metres, about 2500 square metres are occupied by buildings. Recently a new pilot plant laboratory has been put into commission and the *IP Review* editor was privileged to visit Labofina to inspect the facilities available. At the time of the visit work was in hand on the erection of an additional three-storey wing to the main building. This new wing will be used for expansion of the present facilities. There is still space available for further expansion when desired.

The Company is directed by a board of four directors, the chairman being C. Bonnami and the managing director, R. Gillerot. Total staff of Labofina is about 120, of which at least 25 per cent have university or similar qualifications. The general manager in charge of research is Th. de Menten de Horne, the manager of the laboratory and services being G. Souillard.

The work of Labofina is organized in three main departments—Administration, Technical, and Documentation and Information. The Technical Department is further subdivided into five divisions: (a) Testing and Development; (b) Refining; (c) Organic Chemistry; (d) Physics; (e) Mechanical Tests.

The well-stocked library is a valuable part of the research establishment

Although comparatively small in terms of staff employed, this research organization is a completely integrated unit, operating with full exchange of information and services between all sections.

DOCUMENTATION AND INFORMATION

The dissemination of information is one of the most important services which can be rendered to research workers, and particular attention is given to this at Labofina. The Documentation and Information Department is under the control of R. Depelsenaire, a chemical engineer by profession, and he has several qualified chemists on his staff. The Department is also responsible for the preparation of patent specifications and carries out its own literature and patent searches in this connexion.

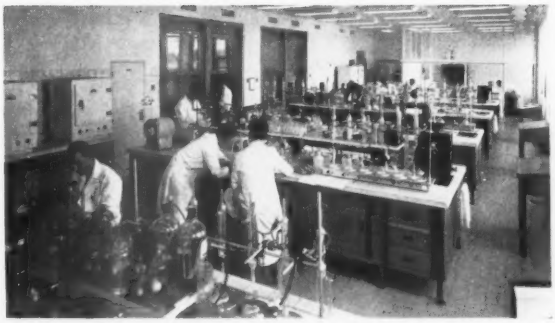
In order to keep technical staff fully and quickly informed of articles currently appearing in the technical press, the Department publishes a weekly *Bulletin Hebdomadaire*. This consists of facsimile reproductions of the contents pages of the periodicals received during the week. Thus, technical staff can quickly run through the lists and decide which, if any, of the articles they need to study. This study can be carried out in the library and, if necessary, photographic copies can quickly be produced.

A second weekly publication, *Bulletin Analytique*, deals specifically with patents issued in various countries. In each case an abstract is provided or details of the main claim are given.

The Department also prepares on request surveys and digests of information on any aspect of the manufacture and utilization of petroleum products. These surveys, which are remarkably complete, are circulated throughout the Petrofina Group.

The method of dealing with literature in Russian is of interest. One member of the staff is very conversant with the Russian language. When an article in that language is of possible interest he tape records a translation. The research worker concerned with the particular subject then listens to the record and decides whether it is desirable to have it produced as a typewritten document.

The library is well-stocked with text books, periodicals, and patent specifications, and operates in close liaison with libraries in Belgium and in other countries.



The testing and development laboratory is well-equipped for its work

TECHNICAL DEPARTMENT

As already mentioned, this Department has five main divisions and these will be discussed in turn. It was particularly noticeable, however, that there is close integration between all divisions and therefore duplication is avoided.

Testing and Development Division

As its title implies, this Division is concerned mainly with normal routine tests of petroleum products and on the development of new products called for by industry. A small amount of research work is carried on but this is mainly short-term in character.

It is under the charge of J. Pierret and, in addition to apparatus for normal IP or ASTM tests, some interesting pieces of special equipment were observed. In most cases, this special apparatus was designed by Labofina and made in their own workshops; for example, a novel piece of apparatus measures the oiliness of a product by the principle of stick-slip. A movable steel block moves over a stationary block lubricated by a film of the oil under test. The motion of the movable block is automatically recorded.

Special attention is paid to the aging of transformer oil and, as the Group markets this product in most European countries as well as in other countries, it is necessary for the laboratory to be able to test to practically all national and international standards. The available apparatus was noted to include that for Belgian, British, French, German, Italian, and Swiss methods as well as those internationally recognized.

Adequate plant is available for the preparation of quantities of new or improved formulations of lubricants, not only in the laboratory itself but also in the new pilot plant building. The lubricant section of this building is in effect a complete plant. Basic ingredients are stored in four tanks on the second floor and gravitate to the blending kettles on the first floor. From the kettles, the product is discharged into drums or other containers on the ground floor ready for despatch to a consumer for testing under practical conditions.

Two blending kettles are available, one of 50 and one of 200 litres capacity, the latter being capable of operating on a recycle system.

An interesting method of examining the effect of cooling rate on finished greases was demonstrated. The product is run into a series of rectangular containers of varying dimensions designed to give different combinations of surface area and layer thickness.

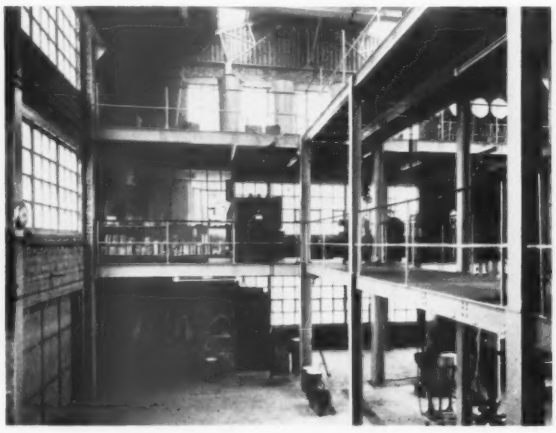
The installation of this pilot plant has already proved its usefulness in giving results of practical application. It is understood that part of the new wing to the main building will be used to extend the laboratories of this Division.

In addition to its work on petroleum products, the Testing and Development Division is also responsible that paints and varnishes purchased by the Petrofina Group worldwide conform to specification. These materials are used for the protection of filling stations and all sorts of containers from drums to ocean tankers, and a book of complete specifications and test methods has been prepared. Special attention has also been given to the designation of colours.

Refining Division

The scope of this Division, which is concerned mainly with the study of high-pressure techniques, of separation techniques, and of catalysts, has been considerably augmented by the provision of space for the erection of pilot plants. Already four such plants had been installed and were in partial operation during the visit. J. Marechal, who is in charge of the Division, hopes to produce some valuable results from these plants.

The lubrication end of the new pilot plant building



The high-pressure pilot plant, which will be employed in the study of catalytic reactions and for the possible evaluation of catalysts, is capable of operating at pressures of up to 200 atmospheres and at temperatures up to 450°C. Reactor capacity is 500 millilitres, the reactor being heated by four electric heaters. The catalyst bed is of the fixed type, the product being introduced by means of a proportioning pump, and hydrogen can be recycled. For the immediate

The high-pressure pilot plant in the new building with the gas chromatograph on the left and—

examination of the circulation gases, a gas chromatographic apparatus forms part of the plant.

For the distillation of crude petroleum, a 100-litre still has been installed. Its column, which is 115 mm diameter and 230 cm high, is packed with Raschig rings and is equivalent to 10 theoretical plates. The still is heated by means of four electric heaters in the body of the mantle surrounding it, and a fifth heater is placed in the top of the mantle. Four heaters are also located around the column throughout its height and there is one heater in the reflux zone. The reflux and condenser can be air- or water-cooled and steam can be introduced into the still to reduce partial pressures.

A 40-litre stainless steel still for the preparation of residues in connexion with the study of asphalts is also available. After removal of light and medium distillates, the residues are recovered by vacuum distillation.

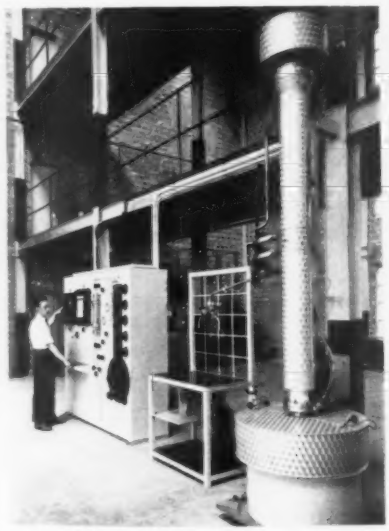
For the preparation of lubricating oils and selected hydrocarbon groups, *e.g.* the extraction of aromatics from reformates, a Podbielniak counter-current solvent extractor has been installed.

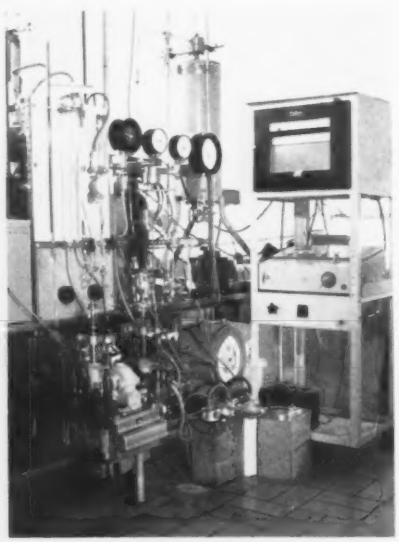
The pilot plant building is sufficient in size for considerable expansion and it was understood that a plant to study the use of platinum-type catalysts for reforming is to be installed shortly.

The general laboratory is exceedingly well-equipped with small-scale apparatus for the study of distillation and other refining problems, the main objects being to develop refinery programmes and to study the behaviour of new crudes and of new products. Thus, for example, there is a wide range of laboratory distillation apparatus varying from columns of a few to 50-millimetres in diameter.

For the study of catalytic reactions, two micro-reactors are available, one having a catalyst capacity of 1 ml and the other 15 ml. A new Brunauer-Emmett-Teller (BET) apparatus is also being used for catalyst study and the usefulness of this is to be extended by the addition of a chromatograph for the immediate checking of results. Some basic work on the physical properties of catalysts is to be undertaken in the near future, particularly in relation to the determination of surface area. An X-ray technique is also to be used.

—the 100-litre crude distillation still





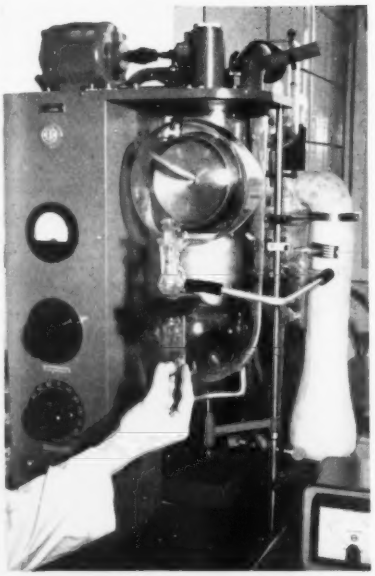
Laboratory apparatus for the study of catalytic reactions

Apparatus is also available for the study of desulphurization catalysts under pressure of up to 200 atmospheres. Capacities are 30 and 100 ml respectively and in both cases temperatures can be measured at any point around the reactor. The smaller appliance has a high-pressure separator and preheater and in both the gas flow can be regulated to within 0·5 litre per hour.

A small high-pressure laboratory is devoted to the study of hydrogenation reactions and is equipped with a 1-litre rocking autoclave and two Magne Dash autoclaves of 100 ml and 250 ml capacity respectively.

Organic Chemistry Division

Under the guidance of P. de Radzitzky this Division is engaged on fundamental research in organic chemistry and in the preparation of new compounds from petroleum. In this latter connexion use is being made of the clathration technique



Close-cut fractions are obtained with this molecular distillation apparatus in the organic chemistry laboratory

for the separation of pure hydrocarbons. This technique was first made use of by the Union Oil Company of California and may be described simply as an organic sieve. It is claimed that hydrocarbons of remarkable purity are obtainable and, among other things, attempts are being made to separate aromate isomers of 99·9 per cent purity.

Another technique used here to give close-cut fractions uses the CEC molecular distillation apparatus.

Particular attention is paid to developments in the production and improvement of white oils and sulphonates and to the application of the latter in industry.

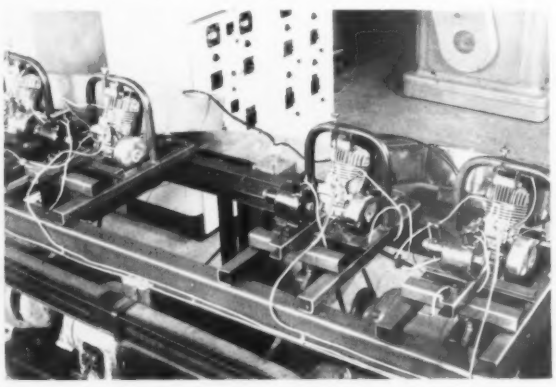
To attempt to describe much of the large amount of basic research being carried out in or visualized for the Organic Chemistry Division is not possible in the available space here. Suffice it is to say that the scope and quality of the investigations in hand are of the highest order.

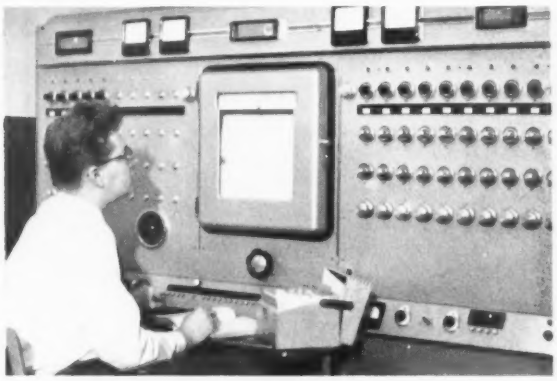
Physics Division

This Division is fully equipped for the carrying out of the most advanced techniques in the examination of petroleum products and has a fully qualified staff of physicists and chemists working under the direction of Dr J. van Rysselberge. The equipment in regular use includes chromatographs, spectrophotometers, and many pieces of special apparatus designed and manufactured in the electronics section of the Division. Incidentally, this section also manufactures special apparatus required by other Divisions and is responsible for the maintenance of all electronic and electrical equipment, recorders, etc.

For the analysis of light hydrocarbons up to C_6 in crude oils, an adaptation of gas chromatography is used. Heavy components are removed by a precolumn and the cutting column is connected to the main column by a three-way magnetic valve system. The detector is a platinum wire katharometer and the weight percentage of light hydrocarbons is calculated from an internal standard. The analysis can be completed within about twenty minutes and the apparatus can be used in the field for analysis of gas or oil straight from a well.

The Mobylette bench in the mechanical tests laboratory carries four engines for comparative tests





The selection and recording panel of the Macq quantimeter in the Physics Division

A well-equipped spectrographic section is part of the Division and has both emission (flame and spark) and absorption (infra-red, violet, and ultra-violet) instruments. A particularly interesting spark emission instrument is a Macq electronic quantimeter of Belgian manufacture. This instrument has a rotating electrode, only requires 2 ml of sample, and is provided with an ordinary and an electronic camera. The first of these has a spectrum range of about 2500Å and is adjustable to cover readings over a complete range of 2000 to 7200Å. The electronic camera has 17 photomultiplying cells, each of which covers the spectrum of one element. The information collected by the electronic camera is fed to a separate recording instrument from which readings can be taken visually and repeated until the record is cleared. A full analysis for 17 elements can be completed in under three minutes.

The instrument is a valuable tool for the examination of lubricating oils to determine additive content, and in the technique of vanadium determination in crude and fuel oils, represents a major advance. An accuracy of 0·5 ppm for vanadium without the need to ash is claimed.

An important programme of work for this instrument concerns the analysis of used lubricating oils on behalf of consumers. By analyses of oils at regular intervals, the presence of extraneous materials will serve to indicate excessive wear by abnormal increase in metals present, efficiency of air filters by the amount of silica present, and so on.

Mechanical Tests Division

This Division is equipped with a wide range of engines for the testing and examination of fuels and lubricants to meet various standards and specifications. These include:

- 3 CFR engines: 1 for motor and research octane ratings of motor fuel; 1 for lean mixture ratings of aviation method; 1 for cetane number determinations;
- 4 Petter W1 gasoline engines;
- 1 Volkswagen engine for camshaft and valve-lifter wear tests in accordance with the Volkswagen Company's method;
- 4 Lauson engines for testing fuels and lubricants;
- 1 Peugeot 403 engine used for "stop and start" tests. Operating conditions are automatically controlled by means of equipment made in the electronics section of the Physics Division and can be varied to simulate working conditions.
- 5 Petter AV1 diesel engines, one fitted with means for measuring wear by radioactive methods;
- 1 Caterpillar for testing to Ministry of Aviation approval, the Company being authorized to issue certificates;
- 1 Anglo-Belge 2-stroke, 2-cylinder, marine diesel engine developing 80 hp at 300 rev/min. This engine is used for wear and detergency tests and is so arranged that different oils can be tested independently and simultaneously.

Two-stroke and scooter motors are also extensively used to carry out tests on lubricants and fuels and include the 49-cc Mobylette, the 150-cc Vespa, and the Johnson outboard motors. The Mobylette bench has four engines all of which can be used simultaneously to test one oil under a variety of conditions of air inlet temperature and other factors.

Road tests are made on a Hillman car fully instrumented to permit study of fuel and lubricant performance under actual running conditions.

The Division is under the control of F. van Quaethoven and, in addition to the engines mentioned above, has some interesting apparatus for carrying out other tests.

For example, an anti-icing test for gasoline is made in equipment designed by Du Pont but fabricated by Labofina. Inlet air to a single-cylinder engine is cooled to 8°C and conditioned to 90 per cent humidity. This air passes through a perforated plate into the induction system surrounding a capillary through which the gasoline is fed to the engine. Measurements are made of the time for the first crystal formation to appear on the copper plate and for a reduction in engine speed.

Cutting oils are also tested in this Division and the David Brown method is used. In this test, the amount of wear on a standard cutting tool is measured when a pre-determined amount of metal has been cut from a standard specimen.

This Division is a member of the IP Correlation Scheme relating to samples of aviation, motor, and diesel fuels. It also participates in the work of the Petter W1 Sub-Panel of the Standardization Sub-Committee on Engine Tests.

Tests on domestic type burner fuels are regularly made in the boilers used to supply hot water to the buildings.

General

The foregoing and necessarily brief account of the research facilities of the "Petrofina" Group should serve to indicate the extent to which the Labofina establishment has grown in the six years of its existence. Plans now materializing and those which will come to fruition in the future will enhance the reputation still further. The organization already holds an important place in the realm of petroleum research and its staff have made a number of valuable contributions to the scientific and technical literature of the petroleum industry. Those of the staff with whom the *IP Review* editor had conversations were enthusiasts and an atmosphere of genial co-operation was apparent throughout. To those who willingly gave so much of their time to explain and demonstrate their work, the editor gives his thanks.

Lectures, Courses, and Conferences

Adjustment to Industry

Particulars of courses to be held by the National Association of Boys' Clubs during the 1960–61 session, on the subject of "Adjustment to Industry", are provided in recent NABC releases.

Formed "to help boys in their first years of work to develop a right attitude towards their employment and to encourage them to use their leisure to good purpose", the courses are residential in character and last for five days.

During this time NABC staff and visiting speakers aim to show the way industry has been developed and is organized to-day, and how activities fostering qualities of initiative and leadership can easily be followed.

Firms are expected to pay the students' wages and to meet the charge of £7 for the board and lodging on the course. Details are available from D. J. Hawes, The National Association of Boys' Clubs, 17 Bedford Square, London, W.C.1.

Special Courses in Higher Technology

Particulars of the special courses in higher technology, including management studies and commerce, available in the London and Home Counties region during the Autumn Term 1960, are given in the *Bulletin of Special Courses in Higher Technology*, 1960–61, Part I, now available.

Most of the courses covered are part-time—usually evening—courses, but full-time ones of not more than three months duration are included.

The *Bulletin* is published by the Regional Advisory Council for Technical Education, Tavistock Square, London, W.C.1, in two parts. Part II, which gives information on courses held in the Spring and Summer Terms, is printed in December. Single copies of each part are obtainable, price 3*s* 6*d* post free—a subscription of 6*s* secures one copy of each part—from the Secretary of the Council.

Notes of the Month

U.K. Oilfield Development

Crude oil production from BP Exploration Company's English oilfields totalled 41,300 tons in the first half of 1960. This compared with a production of 39,840 tons in the first six months of 1959. The main producing oilfields were Duke's Wood, Kelham Hills, Bothamsall and Egmanton (Notts.), and Plungar (Leics.).

Development drilling of the new fields at Bothamsall in Nottinghamshire, and Gainsborough and Corringham in Lincolnshire is now well advanced. In the Bothamsall field 13 successful producing wells have been completed. Production is from horizons in the Lower Coal Measures at a depth of approximately 3000 ft. The crude oil from these wells is taken by road tanker to Tuxford, or to Egmanton for water removal. From Tuxford sidings the crude oil is taken by rail to BP's Pumpherston refinery in Scotland. In the Gainsborough and Corringham fields five wells have been completed, producing from the Coal Measures at around 4500 ft. Oil has also been found in several sands down to 5300 ft in these fields. At the older Egmanton field, equipment for flooding the field has been installed and was commissioned in February 1960.

BP Exploration is also continuing its exploratory drilling activities both in the Midlands area and elsewhere in England. Two wells at Apleyhead and South Leverton (Notts) have recently been completed, and tests of some Lower Coal Measures sands revealed encouraging indications of oil, which suggest the possibility of two more small fields in this region, although further testing will be necessary.

At Kimmeridge, Dorset, where the first significant show of oil in southern England was discovered by BP Exploration Company last year, three wells some 2000 ft deep and a shallow hole have now been completed. The information available from the drilling so far is still insufficient to decide whether Kimmeridge will prove to be a commercial field.

Exploratory Drilling in Iran

NIOC (Depths reached on 6 September 1960).

Alborz No 8 being tested at a depth of 11,525 ft with the last casing placed at 10,697 ft.

Sarajeh No 3 being tested at 12,180 ft with the last casing at 11,723 ft. Sarajeh No 4 is being tested at 10,700 ft with the last casing at 10,699 ft.

Gorgan: NIOC Well No 4 in the Gombad Ghabous area has been abandoned and the rig has been dismantled. Gorgan No 5, not far from the site of No 3 which recently burned out after striking high-pressure gas, is now rigging up.

IPAC (Depths reached on 3 September 1960).

A–1 well in the offshore agreement area of the Persian Gulf will not be drilled beyond the present 13,151 ft. Fishing operations have been completed and the well is being conditioned. B–1 well in the offshore agreement area is drilling at 10,843 ft with the last casing at 4005 ft.

SIRIP

No 1 well in the offshore agreement area is being tested at a depth of 11,011 ft with the last casing placed at 9660 ft. At Sequta in the Zagros agreement area the well has reached a depth of 9282 ft with the last casing at 4238 ft.

Crude Production Milestone in Iran

A milestone in the history of the Iranian oil industry was reached on 29 July 1960 when the 4000 millionth barrel of crude oil was produced from the country's wells, some 48 years after the starting of commercial oil production at Masjid-i-Sulaiman in 1912.

Aerial Surveying of the Indus Waters Area

Before the recent treaty on the division of the waters of the Indus basin was signed by India and Pakistan considerable work had been done preparing the way for the actual engineering and earth moving. The two main schemes consist of a system of link canals and barrages to harness and regulate the waters of the main tributaries of the Indus, and the construction of great storage dams at Mangla and Tarbela with their associated reservoirs.

In each of these projects air photography and large-scale mapping will be done by the Hunting Survey Group. For the Indus canal link scheme, totalling nearly 400 sq miles in length, strips of photography were taken to decide the exact routes, and plans are being prepared from the air cover at 1/3600 or 300 ft to 1 in. In addition, up to 250 sq miles of block mapping is required at canal junctions for various installations and at the sites of the projected barrages. Particular emphasis will be placed on the showing of drains, ditches, nullahs, and other features likely to cause difficulty in the construction work.

In addition the sites of the proposed storage dams have been photographed and maps made, and an investigation is being made at the request of the Water and Power Development Authority into the management of the catchment area serving the reservoir of the Mangla dam. As a first step in this project 2780 miles of the area have been photographed prior to a two-year programme of field investigation.

Pakistan Refinery for International Group

Kellogg International Corp has been awarded a contract to engineer and build a new 34,000 bd refinery for Pakistan Refinery Ltd near Karachi. Participating in Pakistan Refinery Ltd are the Burmah Oil Company, Caltex, Shell, and Stanvac, together with Pakistani interests. Bataafse Internationale Petroleum Mij are the technical co-ordinators for Pakistan Refinery Ltd.

The refinery will consist, in addition to the crude distillation unit, of a catalytic reforming unit and a hydrotreater. Offsites include a marine terminal and a crude oil pipeline from the port to the refinery site. Construction is scheduled to be completed late in 1962.

Persian Pipeline Development

An agreement was recently signed between National Iranian Oil Co and Williams Bros (Overseas) Ltd for the construction of the second stage of the Teheran–Meshed products pipeline, an 8-in line from Shahroud to Meshed. The first stage was completed in August. The 8-in diameter, 93-mile products line from Teheran to Qazvin also became operational early in August.

Good progress is being made on the natural gas line from Gach Saran to Shiraz, and by the end of August pipelaying had been completed up to Marv-dasht, 28 miles from Shiraz.

Special Solvents Plant at Kent

British Petroleum's first installation in the U.K. for the production of a range of special solvents from petroleum spirits has been commissioned at Kent refinery. These solvents are for use in the manufacture of paint and lacquers, and in the essential oils, fatty oils, and rubber industries.

The plant was designed by BP, and has a total annual capacity of 30,000 tons. It consists of two process units for treating the oil, and 17 floating roof storage tanks as well as the necessary associated pumps, piping, and other facilities for road and rail tanker loading.

In the first process unit the petroleum feedstock is treated with strong acid in order to remove any sulphurous compounds. The second process unit then separates the spirit into the fractions required for each type of solvent.

Sub-Sonic Wind Tunnel Research at Linden

An import from the world of music—a Sousaphone bell—has been built into an unusual wind tunnel at the Esso Research & Engineering Co. laboratories at Linden, N.J. This is a sub-sonic wind tunnel in which air travels slower than the speed of sound.

Less generally heard about than the supersonic wind tunnels which are used in aircraft testing, sub-sonic wind tunnels are important in determining facts about air pollution and air conditioning, and in checking aerodynamic shapes used in industry. The precise determination and measurement of air patterns has become increasingly important, particularly in the petroleum industry; without accurate measure an entire air conditioning system can become overbalanced and ineffective, or an oil refining unit can use an uneconomic amount of air.

One of the staff of the Medical Research Division at Linden checks readings during a wind tunnel test.

The new wind tunnel is able to produce and examine air flows ranging from "still air" which actually moves at about 20 ft/min, to air travelling at 5000 ft/min or at the approximate speed of a small hurricane.

The use of the Sousaphone bell was important in the design and successful operation of the tunnel. When air flows through an ordinary opening it flows more rapidly through the centre, and is held back at the edges by friction. Because of its aerodynamic properties, however, the Sousaphone bell gives the same velocity of air across its throat. Instruments will give an accurate reading, therefore, no matter where they are inserted.

Instruments calibrated in the new wind tunnel, which is under the operation of the Company's Medical Research Unit, will be used to measure and ensure proper air flow in ventilating ducts and laboratory hoods in which toxic materials are used.

Shell–Montecatini Polypropylene Plant for Rotterdam

Bataafse Petroleum Maatschappij NV and Montecatini Societa Generale per l'Industria Mineraria e Chimica, of Milan, have agreed to form in common a joint company in the Netherlands to be called NV Rotterdamse Polyolefinen Mij. The purpose of this new company will be to build and operate at Rotterdam, in conjunction with the works of Shell Nederland Raffinaderij NV, a factory destined to manufacture, in the first phase, and on a large scale, polypropylene for plastics.

Shell and Montecatini capital participation will be in the ratio 60 : 40. The sale of the products which will be manufactured in this plant will be restricted at present to the Benelux area, and will be handled by the companies of the Royal Dutch Shell Group through its existing organization.

Polypropylene is the newest polyolefin to be commercialized on a large scale. It is manufactured directly from propylene, using organometallic catalysts of the Ziegler type. The process has been developed by Shell, principally at Koninklijke Shell Laboratorium Amsterdam, and in the pilot plant at Pernis refinery.

Polypropylene has an excellent combination of strength and resistance to shock. It is resistant to temperatures about 60 C higher than conventional low-density polyethylene, and so will withstand boiling water and sterilizing conditions. It has excellent surface gloss and hardness, and in addition, with a density of about 0·90 (water = 1) it is the lightest of all plastics.

These properties make it suitable for many injection moulded articles. Excellent film with high gloss and exceptional transparency can also be produced from polypropylene, and using the latest techniques it is possible to produce an extremely thin gauge film.

Further promising possibilities are for monofilaments in rope and netting, etc., and possibly for fibres for all sorts of textiles and clothing. Sheet, pipes, and electrical insulation are other fields of interest.

ICI–Montecatini Polypropylene Fibre Agreement

A patent licence agreement for the exclusive production in the U.K. of staple fibres, filament yarns, and textile monofilaments from polypropylene has been signed in Zurich between ICI Ltd and Montecatini of Milan.

ICI's plant to make polypropylene for use as a plastic under Montecatini license will come into operation at Wilton, Yorkshire, later this year.

Polypropylene fibres are the outcome of the researches of the Italian scientist, Professor Giulio Natta, and of Montecatini, and the new fibres are currently being produced in Italy by Polymer SA, a Montecatini subsidiary, under the trade name *Meraklon*.

Vapour Lock Trials in Switzerland

Recently BP participated in a series of motor fuel tests on the Susten Pass in Switzerland. The object of these tests was to find out the tendency to vapour lock, or the volatility tolerance, of cars currently marketed in that country. Twenty models of recent manufacture were selected, representing a popular cross-section of the cars used in Switzerland. The base of operations was at Wassen, some 60 miles south of Zurich. The test route was from Wassen to Pfaffensprung to warm up the cars, and then up the Susten Pass to Kleinalptal, a distance of 6·4 miles and a climb of 2260 ft.

Shell at the International Plastics Exhibition

The Royal Dutch Shell Group of companies were represented at the International Plastics Exhibition "Macroplastic 1960" held in Utrecht in October, by an exhibition stand covering 3800 sq ft in which the ever-increasing variety of chemical products, including plastics, synthetic rubbers, and resins derived from oil were featured. It is estimated that, in 1959, Europe's chemical industry alone used about 1½ million tons of refinery and natural gas, and some 2½ million tons of crude and refined oil for the manufacture of chemical products.

The products on display were styrene butadiene, polyisoprene, and polybutadiene rubbers; *Epikote* resins; polystyrene, polyethylene, polyvinyl chloride, and polypropylene plastics.

Another section drew attention to the vast research behind these products and to the technical service laboratories which provide customers with advice on the latest developments in products and techniques.

Harkness Fellowships to the U.S.A.

Applications have been invited for consideration for 1961 awards under the Harkness Fellowships of the Commonwealth Fund. All Fellowships are offered to candidates from the U.K., Australia, New Zealand, and Western Europe, and are tenable in the continental U.S.A.

The Fund is organized for the promotion of international understanding by the granting of opportunities for education and travel in the U.S.A. to young men and women of potential leadership in their own country.

British Fellowships are restricted to citizens of the U.K. and Colonies and are open to those in any profession or field of study. It is preferred that a Fellow should spend the equivalent of two consecutive academic years, including the months of required travel, in the U.S.A. Fellows are required to follow a definite programme of study or investigation approved by the Fund officers and to be based at selected institutions or locations.

Further information and application forms may be obtained from the Warden, Harkness House, 38 Upper Brook Street, London, W.1. Completed application forms must be returned before 1 December 1960.

The Beilby Medal and Prize

Awards are made at intervals by the administrators of the Sir George Beilby Memorial Fund (representing the Royal Institute of Chemistry, the Society of Chemical Industry, and the Institute of Metals), in recognition of independent original work of exceptional merit involving the development and application of scientific principles in chemical engineering, fuel technology, or metallurgy, etc.

Consideration will be given in due course to the making of an award, or awards, in 1961. They are intended as an encouragement to younger men and women (preferably under 40 years of age) and consist of a gold medal and a substantial monetary award.

Further details should be obtained from The Convenor of the Administrators, Sir George Beilby Memorial Fund, The Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

U.K. Petroleum Equipment Orders

The value of orders for materials and equipment placed in the U.K. by oil companies during the April–June period of 1960 were an increase of £2,104,076 over the figure for the corresponding quarter of 1959.

This resulted in a total of £60,628,367 for the first half of 1960, a rise of 7 per cent compared with January–June of the previous year.

Increases in value in the second quarter of this year were registered in specialized equipment for oil refineries (185 per cent); drums and can-making, filling and cleaning equipment, kerbside pumps, etc. (170 per cent); railcars, road tankers, aircraft refuellers, etc. (440 per cent); drums, drumsheets, and tinplate; tankage; pumps (excluding slush, oilwell, and kerbside); electrical equipment; prime movers and compressors; ferrous and non-ferrous plates, sections, sheets, and bars; laboratory equipment and chemicals; and commissary and general requisites.

The remaining categories of materials and equipment declined in value, particularly boilers, boiler house plant and accessories, etc. (83 per cent); and automotive equipment (35 per cent). Full details are given in the table.

	1960 *April–June*	1959 *April–June*
Geophysical and other exploratory equipment, etc.	53,059	82,431
Specialized equipment for oil drilling and production, including oil casing, tubing, etc.	2,274,121	2,970,090
Specialized equipment for oil refineries, etc. (not including pumps and valves)	1,867,572	653,821
Drums and can-making, filling and cleaning equipment, kerbside pumps, and other metering and dispensing equipment, etc. ...	1,253,165	391,132
Railcars, road tankers, aircraft refuellers, etc.	800,081	148,309
Drums, drumsheets, and tinplate ...	1,370,159	1,108,558
Tankage (including tank fittings) ...	1,126,655	661,843
Tubulars, pipe fittings, and valves (ferrous and non-ferrous) ...	2,773,763	2,846,399
Pumps (excluding slush, oilwell, and kerbside)	550,780	532,746
Boilers, boiler house plant and accessories, etc.	136,170	797,038
Electrical equipment—motors, generators, transformers	1,823,079	1,407,467
Instruments, meters, and gauges, etc.	625,378	703,128
Prime movers and compressors ...	986,760	557,264
Machine and hand tools, welding and miscellaneous, machinery and stores	1,640,525	1,802,873
Ferrous and non-ferrous plates, sections, sheets, and bars ...	898,019	579,456
Automotive equipment, all types ...	2,164,753	3,115,832
Laboratory equipment and chemicals, including hospital and medical supplies	450,728	404,807
Bulk chemicals, catalysts, barytes, etc.	6,130,299	6,638,994
Cement and other building materials and hardware, including timber	634,566	655,592
Commissary, general requisites for office, warehouse, household, club and sports, etc.	2,048,472	1,446,248
	£29,608,104	£27,504,028

A Realistic View of the Economic Situation

A speech presented by Diego Guicciardi, president of Shell Italiana, at the opening of this year's exhibition and conference at Piacenza, on "The Oil Perspective in 1960" provides some interesting comments on the present state of the oil industry and is a stimulating example of what can be said publicly regarding oil profits and prices.

The benefits obtained from the industry by many oil-producing countries during the period of post-war rehabilitation were pointed out by Signor Guiccardi. During that era the oil industry itself had been completely overhauled and the search for oil pushed further and further afield.

"In the period from 1948 to 1959 the total capital and exploration expenditure on petroleum amounted to about $103 milliard in the United States and $40 milliard in other countries". This figure did not include the Eastern European bloc.

"From 1948 to 1959, 90 per cent of the industry's capital expenditure has had to be provided by funds generated from its own operations by depreciation reserves in their various forms, and out of undistributed earnings. A mere 10 per cent could be provided by the money markets. Of the 90 per cent provided by self-financing, in fact about 30 per cent has been retained from earnings which might otherwise have been distributed to shareholders."

As a result of the huge investments required by private risk capital an earning capacity and a social advancement undreamt of half a century ago had been brought to a dozen countries. It was easy to say to-day, after success had been achieved, that the profit had been too great and too easy, with no real risk involved.

"It is perhaps one of the great drawbacks to our industry as a whole that we have always been in the progressive van of industrial expansion, that our successes are widely publicized while the long years of money-consuming exploration are forgotten and the enormous sums lost in profitless ventures, as has been the case in so many parts of Africa, North and South America, and in Asia are ignored or forgotten. An oil company in Turkey, after 6 years exploration for oil and an expenditure of $20 million, was recently forced to abandon its search. You may recall that £7 million was spent in Peru and £9 million in Ecuador without any success. In Western Canada, up to 1947 $1400 million had been spent before oil was found and another $2000 million invested before the oilfields could be developed."

The speaker remarked that although people in the oil industry knew of these facts by bitter experience, how often did one hear them referred to by the general public.

The doubling of the world's consumption of oil in the last decade, and the items comprising the enormous investment required to cope with such product movements were outlined, and the role of the industry as a tax collector was emphasized. In Italy, it was said, petroleum was collecting and largely financing one quarter of the entire customs and excise and business tax revenue, whilst the enormous sums tied up in customer credits which oil companies were providing throughout the world sometimes equalled over 10 per cent of the country's national budget.

With regard to the accusations of "international price rings" the speaker said that crude oil prices had been amongst the most stable in a world of fluctuating commodity prices, and that the price of motor gasoline was generally *lower* in real terms than it was before the war. Evaluations of the rate of average profitability of the major industrial groups (outside the United States and Russia) had been made recently by the American journal *Fortune* in a survey of 500 U.S., and the 100 largest non-U.S., companies. This 100 included four major European oil companies engaged in integrated petroleum operations. The evaluations showed an average rate of profitability to the four European oil companies of 6·3 per cent in 1958 and 5·5 per cent in 1959. The 1958 level was only slightly above that of all non-U.S. companies examined (5 per cent): the 1959 level almost exactly coincided with the average. In both years the oil companies ranked below the automobile companies in profitability and above chemicals and iron and steel.

"It has been estimated that in the next 10 years, that is by 1970, world energy consumption is likely to be 60 per cent above the 1958 level, while world *oil* consumption may be no less than 80 per cent higher, thus reaching about 1400 million tons. It is staggering to consider what will be involved in establishing and maintaining the millions on millions of tons of reserves to cater for this fantastic demand of the non-Communist world.

"It is fairly safe to say that by the end of the decade petroleum will be called upon to supply about 45 per cent of the world's energy requirements, excluding the Soviet bloc. If the contribution of natural gas is added to the petroleum effort in the overall energy supply, the share supplied by the industry by 1970 should rise to over 60 per cent."

Recent estimates of future industry expenditure to meet this increasing pace of world oil demand, were quoted.

"It has been estimated, in a report by one of the leading American banks, that about $55–60 milliard may be required to maintain, replace, and expand the essential facilities of the industry throughout the world—again excluding the Soviet bloc—over the 5 years 1960–64. Of this $25 milliard will probably be required in the United States and $30 milliard in other countries. This means that $5 milliard a year will be spent in the States or 7 per cent less than the 1958–59 level—whereas, in countries outside the United States, some $6 milliard a year will be spent, or 7 to 8 per cent above the 1958–59 level. This reflects quite clearly the expected development of demand in countries outside the United States as compared to the already high level of consumption pertaining there.

"This $11 milliard, the average yearly capital requirement of the oil industry, is nearly twice the total amount of Italy's 1959 capital expenditure in all fields of public and private business."

The present depressed condition of oil markets throughout the world brought forth the following comment. "One easily forgets what the oil companies have achieved in times of great world crisis and remembers not so much the excellent and continued service to the customers, nor the progressive social conditions accorded to their personnel, but instead applauds indiscriminately any initiations directed towards reducing, in any way whatsoever, the level of prices. A good company thrives on competition, and price cutting is, of course, nothing new, but what is particular about the present

wave of unsettled markets is the sensationalism in the publicity given to petroleum prices. This is probably a reflection of the tremendous expansion of the industry in which, through the growth of the automotive market and of domestic use of oil and gas as a fuel, millions now have an interest in the petroleum industry which did not exist 15 years ago."

The speaker pointed out that in to-day's conditions a large number of highly-publicized jobbers were "importing cheap cargoes and disposing of them at cut rates." There was a danger that this would result in the oil industry being unable to provide from its reduced receipts the large sums required for capital investment. It was unwise to base the oil policy of a country on the temporary availability of cheap cargoes and a situation of over-supply.

"The consequence of the growing dependence of the free world on oil as a major source of energy is that any check to the rate of investment in the oil industry would necessarily interfere with the maintenance of the overall rate of economic development world-wide. If, as a result of denying the oil companies a fair profit, the flow of funds for reinvestment were to be impeded, the illusory nature of the benefit of unduly low prices to the consumer would soon become apparent. It is also of the highest importance to those countries whose rapid development in the past 50 years has been the fruit of profitable oil exploitation. By oil exploitation we mean the profitable sale of oil to the consumer. Oil in the desert is no more useful than is sand unless it can be conveyed to the world's markets through pipelines, tankers, and the whole network of the industry. There is no magical solution to this problem. It requires money in large sums and the prospect of a fair profit."

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The Oil Industry's Economic Progress

In summarizing the activities of the world oil industry (outside the Communist bloc) in 1959, The Chase Manhattan Bank, in its publication *Petroleum Industry 1959*, reports that compared with 1958 the industry increased crude production by 7 per cent, refinery runs by 8 per cent, and petroleum consumption by 6 per cent.

Consumption of the various forms of energy in 1959, with the percentage increase over the previous year, was as follows:

	1000 *bd*	*Per cent change over* 1958	*Per cent of total*
Petroleum	17,765	+6·0	43·8
Natural gas	5,810	+5·4	14·3
Coal	13,890	−2·3	34·2
Hydro and nuclear ...	3,135	+1·5	7·7
Total	40,600	+2·6	100·0

The use of petroleum outside the U.S.A. showed an increase of 9 per cent compared with about 4 per cent in that country, and accounted for two-thirds of the overall growth in volume. The percentage relation of each petroleum product to the total consumed is shown in the following table.

	1000 *bd*	*Per cent change over* 1958	*Per cent of total*
Gasoline	6,010	+ 4·0	33·8
Middle distillates ...	4,295	+ 3·9	24·2
Residual fuel oil ...	4,680	− 8·2	26·3
Other products	2,780	+10·3	15·7
Total	17,765	+ 6·0	100·0

Estimated proven crude oil reserves, excluding natural gas liquids, were said to be 230,000 million brl at the end of 1959. Of this total the Middle East contributed 145,000 million, the United States 31,700 million, and Venezuela 17,500 million brl. The major problem of the geographical separation of supply and consuming areas is pointed out, and is illustrated in the table.

	Crude production	*Crude reserves*	*Demand*
	Per cent of total		
U.S.A.	42·4	13·8	53·0
Canada	3·0	1·5	4·7
Venezuela	16·7	7·6	0·9
Others	4·8	3·3	7·8
Western Hemisphere	66·9	26·2	66·4
Western Europe ...	1·6	0·6	20·8
Middle East	27·7	63·0	2·7
Far East	3·2	6·3	7·4
Others	0·6	3·9	2·7
Eastern Hemisphere	33·1	73·8	33·6
Free World ...	100·0	100·0	100·0

Crude runs to stills in the non-Communist world were said to be 16·7 million bd in 1959 compared with 15·5 million in 1958—an increase of nearly 8 per cent. Total daily crude capacity at year-end totalled 20·5 million brl.

Capital expenditures for petroleum facilities exceeded $11,000 million in 1959, a rise of 5 per cent over the previous year. Gross investment in fixed assets employed by the industry at the end of 1959 reached $98,000 million, of which 56 per cent was located in the U.S.A. and 44 per cent in the rest of the non-Communist world.

The *Petroleum Industry 1959*, an annual Chase Manhattan Bank publication, is largely devoted to a financial study of the combined operations of 32 major U.S. oil companies during the year.

Twenty-Three Years Search in Nigeria

Oil is playing an increasing part in the economy of Nigeria, which became an independent State on 1 October. The search for oil began there in February 1937, and since then expenditure by the Shell-BP Petroleum Development Company of Nigeria Ltd has passed the £60 million mark.

The first exploration success came when oil was found at Oloibiri (in the Eastern Region, 45 miles west of Port Harcourt), in January 1956, 19 years after the initial geological surveys began. Development work followed and in February 1958, the tanker *Hemifusus* left Port Harcourt, some 25 miles up the Bonny River with the first shipment of Nigerian oil.

Up to the middle of 1959 all the discoveries had been in the Eastern Region—Oloibiri, Afam, Bomu—14 miles south of Afam—and Ebubu, also south of Afam—and considerable development progress was made.

A 60-mile pipeline of 10-in diameter was laid from Oloibiri to the Port Harcourt terminal at a cost of more than £1 million, but unfortunately production is already declining at Oloibiri as deposits are smaller than expected. In January 1958 the Afam field was connected to Port Harcourt by a 25-mile pipeline of 6-in diameter, and later an additional 12-in pipeline was laid to link Bomu with Afam and Port Harcourt.

Meanwhile exploration continued in other areas, and in September 1959 the first significant oil find was made in the Western Region at Ughelli.

During 1959 a total of 35 exploration wells were drilled in Nigeria, nine of which discovered oil. Sixteen appraisal wells were drilled, and all were producers.

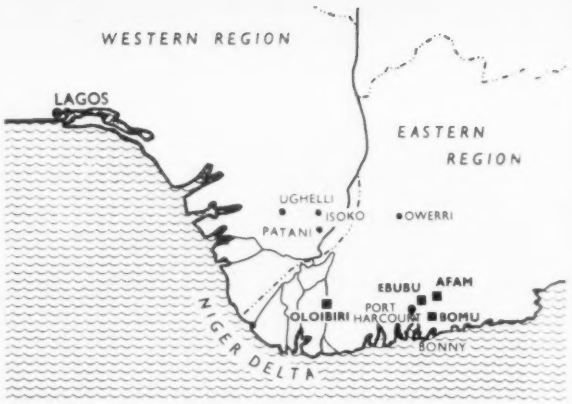
Nigerian oil shipped so far has been exported from Port Harcourt, but in 1959 work began on an £860,000 ocean tanker terminal at Bonny Island, at the river mouth. Oil will be supplied to the terminal by a new 18-mile 12-in pipeline from Bomu.

Experimental dredging has begun on the bar at the river mouth to investigate whether a dredged channel can be maintained at reasonable cost. Such a channel would allow, initially, fully-laden tankers of 18,000 tons, and later after deepening, much larger vessels to pass the sand bar.

At present 18,000-ton tankers going to and from Port Harcourt can clear the bar only when half-loaded and a 12,000-ton "shuttle" tanker has to top them up at moorings eight miles out at sea or at a coastal anchorage.

By the end of 1959, the considerable development work and construction completed but with a lot more to do, Shell-BP had spent some £61 million. During that year crude oil production rose from an average of 6340 bd in the first quarter to 16,000 bd.

The weight of the exploration effort in 1960 has been concentrated in the Delta area. Following the 1959 discovery at Ughelli, measures are being taken to see whether a pattern of oil deposits exists in the general area which can be economically produced and transported. (Ughelli is separated from the nearest producing area in the Eastern Region, Oloibiri, by about 70 miles of difficult country).



In June this year an unsuccessful 14,020-ft well was drilled at the mouth of the Ramos River from one of the two drilling barges now in service in the swamps. Each cost more than £1¼ million to build and was towed the 4000 miles to Nigeria from the Netherlands.

In July two further successful wells were completed in the Western Region, at Isoko and Patani, but—as at Ughelli—further work is necessary to determine the extent of the accumulation. In the same month a successful well down to 14,558 ft was completed at Nun River, in the Eastern Region.

Transport remains one of the most costly and difficult aspects of work in the swamps. One five-mile stretch of road cost £155,000. Extensive use is made of air transport and the versatile twin-engined Prestwick Pioneer aircraft is used wherever the terrain permits an airstrip to be put down. So far Shell-BP has built six of these strips.

Elsewhere helicopters fitted with wheels or floats cut journeys, which would take days through the tortuous creeks and rivers of the Delta, down to hours. For carrying heavy equipment there are giant amphibious tractors and trailers with rubber and steel tracks.

Teaching the Skills

Three years ago there were six Nigerians among the senior staff. There are now 41. This is practical evidence of the efforts being made by the company to develop its Nigerian staff for posts of responsibility. A wide variety of training programmes and courses is in operation. This year 54 young men were chosen for the three-year course at the company's Trade School at Port Harcourt. In addition to the Trade School and departmental training schemes, a new centre is being built at Port Harcourt for executive and supervisory training. Senior staff are also trained by courses and assignments overseas.

Apart from the spreading of knowledge, there are numerous other direct benefits which oil operations have brought to Nigeria.

In 1959 Shell-BP paid £2,616,000 to Nigerian contractors, bought goods in Nigeria worth £1,067,000, spent £1,946,000 in salaries and wages, and paid £219,000 in royalties to the Federal Government.

The principle of 50/50 profit sharing between the company and the Nigerian Federal Government has been established and is now fixed by legislation. In addition to royalties, the government's 50 per cent share includes rentals of oil mining leases, which last for 30 years with a right to renewal for a

further 30 years. In 1960 the rentals will amount to £660,000 and will increase as time goes by.

A significant part of the growth of industry in Port Harcourt has been due to the impetus and encouragement given by oil operations. Management and supervisory activities are being centred there and a new industrial and administrative headquarters is being set up.

Sizeable quantities of gas have also been discovered in the Nigerian oilfields. A power station is already being built in the east Port Harcourt oilfield area to run on gas from the Afam oilfield, and the economic feasibility of establishing a joint BP and Shell refinery in Nigeria to process indigenous crude oil and supply petroleum products for the country's internal needs is now being discussed with the Government.

THE INDUSTRY'S REFERENCE BOOK

For the past 50 years Walter E. Skinner's *Oil and Petroleum Year Book* has been the most complete and reliable compilation of information regarding the companies operating in the world petroleum industry. The 1960 edition, which has just made its appearance, is no exception to this general rule. It comprises nearly 800 pages of which 556 pages are devoted to details of about 1100 of the principal British and foreign oil companies. In each case information is given regarding the operations of the company, its finance, and its directorate. Where appropriate, data is given concerning its production of crude oil, its refinery operations, and so on.

In addition there is a buyers' guide covering over 2000 headings relating to plant, equipment, and accessories for the industry, and there is also a useful list of names and addresses of managers, engineers, and agents.

Two new features are included in the 1960 edition, these being a map showing the status of world oil supply and demands during 1959 and a chart illustrating end use demands of major petroleum products.

Copies of the 1960 edition, the price of which is 40*s* plus 2*s* 6*d* postage, can be obtained from Walter E. Skinner, 20 Copthall Avenue, London, E.C.2. Those desiring to obtain copies are advised to make early application as the demand for this work is always large.

MIDDLE EAST OIL PRODUCTION

	August	*Jan.-August*
	Tons	
Iraq Petroleum Co. Ltd ...	3,024,071	21,774,822
Basrah Petroleum Co. Ltd ...	879,401	7,553,443
Mosul Petroleum Co. Ltd ...	106,903	869,224
Qatar Petroleum Co. Ltd ...	692,115	5,390,916
Iraanse Aardolie Exploration en Productie Mij	4,299,000	32,205,000
Kuwait Oil Co. Ltd	6,689,659	52,884,675
	Barrels	
Arabian American Oil Co. ...	35,950,976	294,954,877
Bahrain Petroleum Co. Ltd ...	1,396,907	10,997,603
Getty Oil Co. and American Independent Oil Co. (Kuwait-Saudi Arabia Neutral Zone)...	4,175,457	31,684,623

The refinery throughput at Abadan of the Iraanse Aardolie Raffinage Mij for August was 1,669,000 tons, the total for 1 January to 31 August being 11,317,000 tons.

Crude processed at Aramco's Ras Tanura refinery during August was 7,490,636 brl, the total for 1 January to 31 August being 53,806,645 brl.

Automatic Order Recording and Invoicing

The sales clerk takes telephone orders and records them on DORIS' system of buttons

Shell-Mex and B.P. Ltd has been using its Royston installation as a testing ground for some developments in methods to keep its internal efficiency abreast of expanding business.

Apart from the equipment for the remote control of the opening and closing of valves, and recording the quantity and temperatures of product storage which was reviewed in an earlier issue of the *IP Review*, an experiment called DORIS consists of a number of machines working in partnership in a Direct-Order-Recording-and-Invoicing-System, the only one of its kind in the world.

A two-year study into the specially-designed equipment necessary for the mechanization of depot clerical work was carried out by the Company in conjunction with Creed & Co. Ltd, a well-known teleprinter concern. It was decided that electro-mechanical rather than electronic devices would be best suited for such a purpose, and an experimental system was installed at Royston in July of this year.

The heart of DORIS is an "input console" of 3000 buttons for an alphabetical list of customer's names and addresses. About 85 per cent of orders arrive by telephone, and, when a customer rings up, the sales clerk sets the equipment to work by pressing the customer's particular name and address button. He then turns his attention to a panel on which, by pressing other buttons, he records the details of the order.

One group of buttons will register any quantity of product from 1 to 9999 gallons, while another series deals with different types of products. The day of delivery, the packaging instructions and the method of delivery are also recorded by the operation of buttons. A buzzer and the appearance of a red light will remind the sales clerk of any button operation he has overlooked.

After the sales clerk has recorded the basic facts, DORIS selects from a mechanical "memory" all the other details about the customer and the products ordered to enable the sales ticket (or delivery note) to be typed out automatically.

A standard five-digit punched tape is read automatically and the issue document is first prepared with the aid of separate reels of seven-channel tape which give particulars of each customer divided into static-address details and terms of trade detail. At Royston three reels contain addresses and three terms of trade, whilst one gives product details.

The input reader mechanism identifies the customer number and the tape reels revolve at 45 ft sec whilst a photo-electric cell counts the channel holes on the tape until the required customer information is reached. The reader mechanism identifies the required product and details are selected from the product reel by the same process. Sales tickets and invoices are printed simulataneously on the machine and the value of the order worked out. At the same time the running particulars of the day's transactions are punched on perforated tape on another machine to provide the divisional office with the required statistical and accountancy information.

The CBMPE Dinner

EXPORT COMPETITION TOUGHENING

With over 1500 members and guests, this year's annual dinner of the Council of British Manufacturers of Petroleum Equipment established a new record for attendance. Principal guest was Sir John Wrightson, Bt, T.D., chairman of Head, Wrightson & Co. Ltd, and the dinner was presided over by J. M. Storey, C.B.E., chairman of the Council. The Rt Hon. Reginald Maudling, P.C., M.P., President of the Board of Trade, was among the official guests.

Proposing the toast *The Guests*, Mr Storey said:

"Recently, the Prime Minister said it was 'fun' to export. I think we are all agreed that it is not quite so 'funny' as it used to be. Continental competition is becoming tougher and I am afraid that not so very far round the corner the cold war could quite easily turn into a hot trade war and I am sure we would all like to know what HM Government is going to do about it. Recently, we were informed that the Minister of State to the Board of Trade is going to circulate 30,000 firms with a letter telling them the sort of help that the Board of Trade can give them to increase their exports. We await this letter with interest. From the circulated list, it is apparent that the pressure to export is being applied not only to the large firms in the country but also to small firms and this brings me around to the holy word of 'ECGD'. The nations of the world and for that matter, the peoples of the world, are living more and more on long term credits. I wish someone would write 'A Child's Guide to ECGD' such that it would enable me to understand it. I heard a businessman say the other day that it would be a very good idea if ECGD were de-nationalized! One thing seems certain, a new approach has to be made to long term credit facilities, such that the small firms handling relatively small contracts can be encouraged to get into the export business and thus swell the ultimate total. Terms must be arranged to enable us all to compete in the long term credit facilities market."

On the question of taxation, Mr Storey said that this was important in the cost make-up of any project and heavy tax burdens did not assist in meeting overseas competition. An export encouragement was needed. He further suggested a multi-lingual Board of Trade Export Journal to be exported free and to carry reasonably cheap space to encourage the smaller firms to advertise their wares.

Referring to the British Oil Equipment Credit Company (BOEC) the chairman said that their first customer was Petroleos Mexicanos and some £3½ million worth of credits had already been placed with Members of the Council.

Mr Storey regretted that indisposition prevented T. L. Bonstow being with them that evening. He had hoped to have had the pleasure of presenting to Mr Bonstow a silver rose bowl as a mark of their appreciation of the excellent work which he had carried out for them over the years.

Sir John Wrightson, responding on behalf of the guests, commended the setting up of BOEC, an indication that British industry was not prepared to sit still. Exporting

The chairman of the Council, J. M. Storey, C.B.E., welcoming the guest of honour, Sir John Wrightson, Bt., T.D. (right)

was fun but they should not imagine that long term credits and indiscriminate granting of facilities to all and sundry was the panacea. Their future must be bound up with the growth of the world petroleum industry, the whole pattern of which was changing rapidly. As Dr Paul Frankel had recently written: "The fact that international oil was for a long stretch of its history almost an American and British preserve was an historical accident". That accident was their opportunity.

Concluding, Sir John said:

"Now in the 1960's our Council must take advantage of the new patterns. We must fashion our policies so that we retain our firm and trusted friends and yet make new customers. This is not incompatible. With the constantly rising world consumption of oil the prime interests of producing countries and international distributors must gradually coincide. Low prices for petroleum can only debase world trade. It is to this unity of purpose in the political, industrial, and commercial spheres that we can hopefully look to the future."

* * *

UNION CARBIDE GRANTS FOR SOUTHAMPTON UNIVERSITY

To encourage and advance research in the field of chemistry, the Chemicals Division of Union Carbide Ltd, which has a major petrochemicals plant located at Hythe, Hampshire, is making a grant of £2150 per annum for three years to Southampton University and will later consider an extension of this award. The grant will provide for a research studentship and a research fellowship in synthetic organic chemicals in the University's Department of Chemistry. The studentship will assist promising students chosen by the University to work for a Master's or a Doctor's degree and the fellowship should stimulate research atmosphere.

The Alloys Division of the company is giving similar support to other Universities, notably fellowships of £450 per annum to Sheffield University and £450 per annum to the Royal College of Science, Glasgow.

Australian Oil Search

The Australian Bureau of Mineral Resources has published a report on Australian oil search during the three months May–July 1960. The following is a summary of this activity.

Queensland

Near Beaudesert, Queensland American Oil Co. abandoned Overflow No 1 at a final depth of 2993 ft after drilling in volcanic rock from 1620 ft.

About 20 miles east of Roma, Associated Australian Oilfields NL spudded in Pickanjinnie No 1 in May. The well reached a final depth of 5213 ft and finished in metamorphosed sediments. During drilling two drill-stem tests gave 2½ mmcu ft/day and 1 mmcu ft/day of gas respectively. On completion of drilling, casing was run and cemented and detailed production tests were carried out through perforations on the two intervals. The upper interval produced 5·712 mmcu ft/day. A test on the lower interval indicated that communication existed between the two zones and produced gas at the rate of 6·5 mmcu ft/day with some condensate. The company is moving to a location at Latemore Creek about 3 miles to the west.

At Ooroonoo on the Diamantina River near Brighton Downs, Conorada Petroleum Corp's Coroonoo No 1 was drilling at 1688 ft at the end of July. The well has a target depth of 4000 ft.

At Corfield, near Winton, Magellan Petroleum Corp undertook the deepening of the Corfield Water Bore from 2726 ft to the target depth of 6000 ft. The well reached granite at 4490 ft, and was abandoned at 4507 ft on 15 June.

Other operations in the state have included geophysical surveys in the Dalby, Goranba, and Bluff areas by the Bureau of Mineral Resources. Other organizations active in exploration in the State are Phillips Petroleum Company; Delhi Australian Petroleum Ltd and Santos Ltd; Australian Oil and Gas Corporation Ltd with Union Oil of California; and the group comprising the Associated Australian Oilfields NL, Associated Freney Oil Fields NL, and the Papuan Apinaipi Petroleum Co. Ltd.

New South Wales

Exploration has been confined to aerial and geological surveys. The Texas Australian Oil Company, an Australian subsidiary of the Texas American Oil Corp, has been carrying out surveys in the Hay and Balranald areas. Australian Oil and Gas Corp Ltd, and its associate Union Oil Development Corp (Union Oil of California), plans to carry out an extensive survey of their holdings in the Hunter River valley.

Victoria

At Rosedale, Gippsland, APM Development Pty Ltd completed its stratigraphic test Rosedale No 1 on 10 May at a final depth of 5836 ft in sandstone. The well was electric logged and abandoned.

In the Port Campbell area, following the discovery of gas in Port Campbell No 1 well, further seismic surveys were carried out, and as a result of these Frome-Broken Hill Co. Ltd are drilling Port Campbell No 2 about 1¾ miles to the south-east. Planned to 10,000 ft it was drilling below 5827 ft at the time the report was published.

Tasmania

The first large oil exploration tenements to be granted in this State have been issued to the Broken Hill Pty Co. Ltd, covering 28,975 sq m of the offshore area of Bass Strait between Tasmania and Victoria.

South Australia

The seismic survey in the foreshore area of the Adelaide Plains carried out by Geosurveys of Australia Ltd has been completed. It is probable that the survey will be extended into the marine offshore areas later this year, and this would be followed by drilling if the results proved favourable.

A gravity survey carried out by the South Australian State Department of Mines will start shortly from Oodnadatta. Exoil Pty Ltd is to make a geological survey of the Officer Basin in the Woomera area.

Western Australia

West Australian Petroleum Pty Ltd abandoned Barlee Well No 1 on 26 July at a final depth of 8101 ft. The last 6000 ft was in monotonous sandstone-siltstone formation. A comparison of the results obtained from the well with those of other deep wells drilled in the Kimberleys indicated this zone to be one with very few prospects. Wapet's seismic survey in the Dampier Fault area has been completed, and the seismic party has moved to the Perth Basin where it is now working in the Hill River–Dongara area.

Northern Territory

Drilling has recommenced at Spirit Hill No 1 after suspension at the end of 1959 due to monsoonal rains and flooding. The well, which has a target depth of 3000 ft, is being diamond-drilled throughout, and is currently below 2480 ft.

Delhi Australian Petroleum Ltd, Santos Ltd, Geosurveys of Australia Ltd, and Flamingo Petroleum Ltd are all undertaking geological or geophysical surveys in their respective tenement areas in the Territory.

Papua–New Guinea

On 22 July Australasian Petroleum Co. Pty Ltd spudded-in Iehi No 1 well about 10 miles north of Barikewa No 1. Access to the site is very difficult, and the operation is maintained by helicopters operating from a base on the Kikori River. The well was drilling below 3432 ft at the time the report was published.

The Trans Hegigio geological survey field work carried out by APC has been completed and the results are being examined.

FLOW PROPERTIES OF ADMIRALTY FUEL OILS

The seven papers on this subject which appeared in the May and June issues of the IP *Journal*, together with the report of the discussions, have now been reprinted and are available as a separate book. Copies, price 15*s* post free, are obtainable from the offices of the Institute.

Books and Films

Sea and Country

Two Esso Petroleum Company films recently shown for the first time at the Edinburgh Festival, and now available for loan, provide a pleasant contrast in the types of films produced by oil companies.

The one, *Tanker Voyage*, is concerned with the routine work aboard a typical 36,000-ton tanker outward bound from Fawley to Kuwait. The subject vessel is the *Esso Durham*, and life aboard her is seen through the eyes of a young cadet fresh from school and full of the new life on his first voyage. We are provided with many glimpses of the life aboard such a vessel, observing both the officers and crew at their various jobs and seeing the excellent food and accommodation provided for all ranks. An idea is also given of the sort of tuition which the young cadet undergoes in the making of a deck officer, and should prove instructive to aspiring lads who no longer have to run away to sea. The film is in 16 mm and runs for 24 minutes, and the colour is particularly striking in the scenes when the vessel passes through the Suez Canal.

The second film, *Pembrokeshire My County*, is concerned with the non-industrial aspects of that south-western county which might be deemed an unspoilt Cornwall. It runs for 27 minutes, is in 16 and 35 mm, and is in Eastmancolor. It is said that the film was a joy to make and that can easily be believed, for the camera dwells with a superb eye for wild beauty on the open moorland, the autumn tints of the forests, and the rugged precipitous grandeur of the coastline. In spanning the seasons of the year the watcher also sees the old churches, the multiplicity of castles, and the Celtic burial grounds which make one imagine that Pembrokeshire must in many parts have remained almost unchanged through the centuries. The wandering streets of some of the county towns are seen, but there is little of brickwork and masonry—and the petroleum facilities at Milford Haven are carefully omitted. The glory is of the coast and country, and of the bird and animal life there—for this aspect of the photography would do credit to a nature film of the highest class. The closing remark of the commentary is that "time lies easy on Pembrokeshire". One wonders with apprehension whether this will continue to be said in the future, when industrial complexes and the attendant populations of red brick make their scheduled appearance in areas of new industrial development.

The officer cadet practices navigation under the eye of the First Officer of the Esso Durham. *A scene from the film "Tanker Voyage"*

An Esso photograph

Tanker Voyage Chartering Review

Some clear distinctions between the trading patterns of tankers above and below the 20,000 dw tonnage mark emerge from a recent Westinform report on "Tanker Voyage Chartering in 1959 and Early 1960".

A general survey shows that, in tonnage of cargo fixed, the Caribbean is well ahead of the Persian Gulf when clean and dirty are taken together, but that the two areas are of equal importance for dirty cargo alone. Subdivision of the fixtures by ownership reveals that nearly 10 per cent of all cargoes were carried by ships belonging to oil companies, a sign of the times when considered in relation to the normal chartering activity of the major oil concerns.

Further subdivisions of the over 20,000-ton group brings out the dominance of the Persian Gulf in this size group, and the fact that tankers of this size are still only rarely fixed to carry clean cargo. In the under 20,000-ton group, the Black Sea is second in importance as a loading area only to the Caribbean, with a great majority of loadings for European destinations.

U.S. coasting is treated separately, and in these trades company-owned ships are shown to be remarkably prominent, as are vessels larger than the T2. Throughout the report, complete tables are given in which tonnages fixed are analysed both by loading and discharge areas.

Separate copies of this report may be obtained from W. G. Weston Ltd, 26–27 Cockspur Street, London, S.W.1, at a cost of £2 each (postage extra).

Advice on Use of Portable Oil Heaters

Several notable changes in recommendations have been made in a revised leaflet on "Portable Paraffin Heaters" issued by the Fire Protection Association. These include the recommended use of water in the quelling of fires in such appliances, the cooling of the heater being the most important factor.

In a second FPA leaflet owners of unmodified drip-feed oil heaters, not marked as complying with BS 3300 introduced last March, are strongly urged to get in touch with the manufacturers who will advise on the best methods of modifying the heaters to make them safe in draughts of up to the recommended limit of 17–18 mph.

Both leaflets have been prepared by a committee which includes representatives of Government departments, Fire Brigades, insurance companies, the Fire Research Station, heater manufacturers, oil companies, and the FPA. Copies are obtainable free of charge from the Fire Protection Association, 31–45 Gresham Street, London, E.C.2.

U.S.S.R. Patents and Inventions

Publication has recently started of "U.S.S.R. Patents and Inventions" which is a translation of the Russian journal *Biulleten Izobretenii*. The Russian is issued 24 times a year but the translation appears monthly and each issue contains abstracts of two Russian issues. The abstracts of patent specifications are subdivided into seventeen sections and are further classified in each section.

Annual subscription is £50, but subscription to the specialized sections are available at £10 or £15 per section. English translations of any Russian patent and/or a photostat copy of the original can also be supplied. Publishers are Pergamon Press Ltd, 4 and 5 Fitzroy Square, London, W.1.

British Welding Research

The expanding nature of the welding industry is amply illustrated in the 1959–60 Annual Report of the British Welding Research Association, Abingdon Hall, Cambridge. It is reported that, apart from maintaining a large "minimum" programme of work, the Association is increasingly being called upon to meet specific problems in design, in selection of welding conditions, and in the choice of materials. As a result the BWRA liaison and advisory services have been considerably strengthened to meet these demands as well as to make the results of general research available without delay.

The report shows how the research work of the Association has a very real bearing on industrial problems and economics, and reviews the year's research in fatigue investigations; the brittle fracture of steel; pressure vessels and pipelines; fundamentals of arc welding; resistance welding; and ferrous and non-ferrous metallurgy. A further section is devoted to a description of the research sponsored at universities.

A Story of Chemical Progress

During the 1880's, at the height of the Victorian era of booming trade and industrial invention, a hydrogen peroxide works was established at Shipley, Yorks, by a young Belgian, Bernard Laporte. The company which he formed there has long since become one of the largest manufacturing and trading concerns in the British chemical industry. To-day Laporte Industries Ltd is a group of 11 companies operating 16 production units in the U.K. and in Australia and Canada. It is the largest producer of hydrogen peroxide in Britain, one of the largest producers of sulphuric acid, the main producer of Fuller's earth, and a large-scale manufacturer of titanium oxide and a wide range of industrial chemicals.

The present structure of the Group, its history, and its activities are described in a 70-page illustrated book which has been produced by Laporte Industries Ltd, Hanover House, 14 Hanover Square, London, W.1, in conjunction with their annual report for the financial year ending 31 March 1960.

The Raw Materials of Progress is a story of industrial growth in the sphere which has been undergoing some bewildering transformations since the Shipley firm was begun 80 years ago. The account of the part played by the Group in the pioneering of some of the methods and materials, and its probable place in the chemical future, is not only a story of the growth of an enterprise but of the developement of a new technological era.

Survival at Sea

The fire and safety officer of Regent Oil Company Ltd has just had a book published by William Kimber that tells of his experiences under a different kind of fire and safety to that which now engages his attention. *Life-boat Number Seven* by Lt-Commander Frank West tells the story of the sinking of the s.s. *Britannia* in March 1941 by the gun-fire of a German armed merchant cruiser, and of the subsequent voyage of a boat-load of survivors. Eighty-two men filled the life-boat and covered 1500 miles across the Atlantic Ocean in 23 days at sea. For most of the time they had no food and only a small cupful of water each a day to keep them alive under the fierce sun. Of the original 82, only 38 survived.

The story has been compared with some of the greatest epics of survival at sea.

The Storage of Petroleum Spirit

A revised edition is now available of that extremely useful booklet *The Storage of Petroleum Spirit and Petroleum Mixture*, published by the Fire Protection Association, 31–45 Gresham Street, London, E.C.2, price 2*s*.

The booklet has been prepared as a guide to all those responsible for the safe keeping of petroleum spirit from storages of up to three gallons to major installations, covering all aspects of the correct storage practice. The legal requirements and the best methods of fire protection are fully dealt with. Most important, the often complex regulations are presented in a particularly lucid and understandable form. Appendices give particulars of the subject of electrical apparatus in use near petroleum storage; fire extinguishers; and examples of substances having a flash point below 73°F.

Refinery Materials

Procurement was the title of a film recently shown in London by the Kellogg International Corporation. It gave an extremely vivid picture of the planning, co-ordination, and teamwork involved in procuring materials for the construction of a refinery, such as the new BP Benzin und Petroleum AG plant at Dinslaken.

Study Conference on Britain's Coal

The report of the study conference on "Britain's Coal" which was held at Grosvenor House, London, in March 1960, has now been published.

Papers presented and published in full are "Coal—The Next Fifty Years" by E. F. Schumacher, economic adviser to the NCB; "Coal—The Present Situation" by S. Kessler, research officer of the NUM; and "Coal and Science" by Dr D. T. A. Townend, director-general of the British Coal Utilization Research Association. The discussion to the second paper was opened by C. M. Vignoles.

"Britain's Coal" is published by the National Union of Mineworkers, free of charge.

An Introduction to Ion Exchange

Ten years ago, knowledge of ion exchange was confined to a comparatively small number of experts, and its commercial use was limited almost entirely to water softening and water demineralizing. The chemical literature to-day describes an increasing use of ion exchange in analysis and research, and in large-scale chemical production. The subject is frequently included in degree courses, and numerous text books have been published.

The Permutit Co. Ltd has now produced an instructional film in sound and colour that will form an introduction to the subject, both for students and for potential industrial users. The film opens with a rapid survey of the uses of ion exchange in industry and research. Then, with the use of molecular models, the structure of ion exchange resins is examined. The incorporation of the active groups into the polystyrene network, and the inter-relation of the fixed and mobile ions with the resin skeleton are illustrated.

Animated diagrams, used alternatively with column experiments, explain the basis of the ion exchange technique.

The film runs for 27 minutes, is produced in 16 mm colour, and has an optical sound track. It will be available in 1961 for free loan on application to the Permutit Co. Ltd, Permutit House, Gunnersbury Avenue, London, W.4.

The Avro 748 shows its form at Farnborough

A Shell photograph

The 1960 Farnborough

Aircraft are to-day almost essential to the petroleum industry for the rapid transport of personnel or of equipment. It is not surprising, therefore, that many oil men were to be seen at Farnborough during the 21st Flying Display and Exhibition of the Society of British Aircraft Constructors, 5–11 September. The flying display was fully up to the high standard set by previous shows and demonstrated in no uncertain manner the reliability and versatility of British aircraft and equipment. Only one completely new machine, the Avro 748, a short medium range airliner, was flown, although the Short Brothers & Harland Ltd SC1 made its first public appearance. This is an experimental vertical take-off lift (VTOL) aircraft which demonstrated its ability to take-off vertically, convert to forward flight, and land vertically.

There were altogether 382 stands in the various exhibitions and among those who were exhibiting were a number of IP member-companies. Brief references to their exhibits follow:

English Electric Co. Ltd.—Electrical equipment for aircraft, for guided weapons, and test rigs.

Esso Petroleum Co. Ltd.—Petroleum products for aviation and on their handling and use.

The General Electric Co. Ltd.—Equipment for galleys and for lighting; electronic equipment; missile guidance.

Laporte Chemicals Ltd.—High test peroxide as a source of power for rockets, etc. Catalysts for polymerization.

Manchester Oil Refinery (Sales) Ltd.—Fluids for non-destructive flaw detection and specialized oil products.

Mond Nickel Co. Ltd.—Technical publications and data on nickel alloys.

The Pyrene Co. Ltd.—Fire detecting and extinguishing systems. Crash tenders.

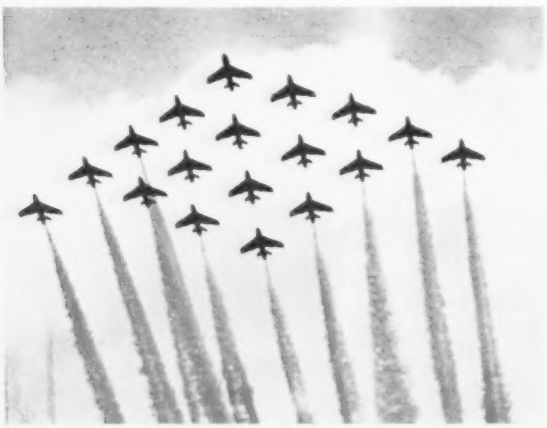
Rubery, Owen & Co. Ltd.—Welding equipment, metals, and aircraft parts.

Serck Radiators Ltd.—Oil coolers, fuel heaters, de-icing, and test-bed equipment.

Shell-Mex and B.P. Ltd.—London Airport development 1946–60 and development of aircraft fuelling.

Aerobatics by No 111 Squadron, RAF, in Hawker Hunter F. Mk 6 jet fighters

A Shell photograph



The Short SC1 VTOL research aircraft powered by four Rolls-Royce RB 108 turbo jet engines

A Shell photograph

Analysis of World Tanker Carrying Capacity

The world fleet of ocean-going tankers of 2000 gross tons and over totalled 3276 vessels of 62,657,800 dw tons at the end of 1959, according to the eighteenth annual *Analysis of World Tank Ship Fleet* published by the Sun Oil Company. This aggregate was equivalent to 3826 T-2's.

In terms of carrying capacity there was a rise of 12·4 per cent compared with the figure at the end of 1958, a slight gain on the average annual rate over the last five years of 11·5 per cent. In spite of this, due to the high level of scrappage, it was not so high as the increases registered over the last two years.

Liberia was once again the leading flag of registry—although nearly half of its tonnage was under U.S. control—and on a T-2 equivalent basis was followed by the U.S.A., Norway and the U.K. who virtually tied for third position, and Panama. These five flags accounted for seven-tenths of the world's total carrying capacity. Deliveries to owners operating under the U.S. flag were the highest in any postwar year. Supertankers (24,000 dw tons and over) continued to represent an increasing proportion of the world's total carrying capacity, accounting for over two-fifths of the world's T-2's compared with the share of less than one-fifth five years earlier. Vessels of 40,000 tons and over represented almost one-eighth of world carrying capacity at the end of the year under review.

At the close of the year 523 ships of approximately 19·8 million dw tons were under construction or on order. This contrasts with the total of 803 vessels of some 28·5 million tons a year previously. The average size of ship was 37,800 dw tons. The U.K. was the leading country of construction (and had the most tonnage destined for its registry) and was followed by Japan, Sweden, and Germany. Together, these four countries accounted for three-fifths of the tonnage being built or on order.

WORLD TANKER FLEET AT 31 DECEMBER 1959
(Ocean-going vessels 2000 gross tons and over)

Country of registration	*No.*	*Actual dw tons*	T2–SE–A1	
			No.	*Per cent of world total*
Liberia	432	12,264,800	794·3	20·8
United Kingdom ...	569	9,576,100	555·6	14·5
Norway	504	9,396,800	555·8	14·5
United States:				
Oil companies ...	202	3,773,800	237·6	6·2
Non-oil companies	135	2,859,300	183·4	4·8
Government ...	148	2,133,200	142·0	3·7
Total U.S.A. ...	485	8,766,300	563·0	14·7
Panama	189	3,932,400	244·8	6·4
France	126	2,732,300	169·9	4·4
Sweden	122	2,329,700	141·1	3·7
Italy	128	2,359,300	143·3	3·8
Japan	94	2,066,200	128·4	3·3
Netherlands	111	1,853,400	109·4	2·9
Denmark	63	1,245,500	76·2	2·0
U.S.S.R.	87	959,700	48·7	1·3
West Germany ...	45	907,600	56·9	1·5
Others	321	4,267,700	238·7	6·2
Total	3,276	62,657,800	3,826·1	100·0

In addition to a more detailed discussion of the foregoing facts, and copious statistical tables of tanker ownership, the Sun Oil Co. study reviews the tanker outlook situation. The composition and size of the world tanker surplus is investigated for U.S. and other "foreign" flag fleets respectively.

Scottish Petroleum Consumption

During the first half-year of 1960 1,698,938 tons of petroleum products were consumed in Scotland—a rise of 207,489 tons over the corresponding six months of 1959, according to statistics released by the Petroleum Information Bureau on behalf of the Petroleum Industry Advisory Committee. The second quarter total in 1960 of 855,087 tons also compared favourably with the 843,851 tons of the January–March period.

Once again the only products to suffer a decrease compared with January–June 1959 were aviation fuels, burning oil, vaporizing oil, and paraffin wax and scale. The largest individual product rises were 63 per cent in the consumption of industrial spirit and 46 per cent for petroleum gases. Fuel oil use increased by 26 per cent. Full details are given in the table below.

SCOTLAND: DELIVERIES INTO INLAND CONSUMPTION OF PETROLEUM PRODUCTS

Product	*January to June*			
	1959		1960	
	tons		*tons*	
Aviation fuels		85,800		75,881
Motor spirit (incl. motor benzole):				
Premier grades ...	154,613		178,907	
Standard grades ...	104,779		99,252	
		259,392		278,159
Industrial spirits (incl. industrial benzole) ...		22,354		36,545
White spirit		4,082		4,180
Kerosine:				
Burning oil	42,751		41,457	
Vaporizing oil	19,836		15,360	
		62,587		56,817
Derv fuel		123,658		136,956
Gas, diesel, and fuel oils:				
Gas/diesel oil	175,080		189,445	
Fuel oil	364,800		458,274	
Refinery consumption...	141,482		170,338	
		681,362		818,057
Lubricating oils and greases		36,067		39,185
Paraffin wax and scale ...		1,708		1,514
Petroleum gases		6,232		9,081
Bitumen		88,268		92,602
Other products		119,939		149,961
		1,491,449		1,698,938

Trade Literature, etc.

Single Unit Road Tankers

In the "BP Autotanker", a new type of road tanker built by Thompson Bros of Bilston, Staffs, in conjunction with Leyland Motors Ltd, the cargo tanks, driver's cab, and chassis frame have not been constructed separately, but are combined in one single unit in an aluminium alloy body, thereby achieving a considerable saving in weight.

Designed for 24 gross tons rating, the 8-wheeled vehicle can carry an assorted cargo of 4000 gal in six compartments. The tank is about 2 ft lower than in the conventional road tanker, which results in a lower centre of gravity and much improved stability. Other features of this prototype vehicle, which will go into service with BP's Danish associate BP Olie-Kompagniet A/S, are semi-automatic transmission, an air-suspension system which makes the springing of the vehicle suitable for varying loads, and automatic chassis lubrication.

Elektrion Change of Address

Société des Huiles De Cavel & Roejiers SA has transferred its head offices and laboratories to Nieuwe Wandeling 19, Gent.

Expansion by the Pyrene Company

The Pyrene Company Ltd has acquired the business of Messrs S. F. Roberts Ltd, which will become one of the Pyrene Group, and manufacture of its range of safety products will be carried out at the Windmill Road Works, Brentford.

In future the name of the newly-acquired Company will be Messrs S. F. Roberts (1960) Ltd.

Instruments for Air-Photo Study

Hilger & Watts Ltd, 98 St Pancras Way, Camden Road, London, N.W.1, has announced the availability of catalogues concerning several new instruments for the study of air photographs. These include the *Steroskетch* for direct sketching of photographic detail; the recording steriocomparator for measuring co-ordinates in forms suitable for electronic computors; the transformation printer; and a light box for use with the Old Delft scanning stereoscope. The introduction of a vertical calibration goniometer for survey camera lenses is also announced.

"The ABRAC Grades of Aluminium Stearate"

A revised edition of the technical information bulletin on "The ABRAC Grades of Aluminium Stearate" has been issued by A. Boake Roberts & Co. Ltd, Carpenters Road, Stratford, London, E.15. The leaflet describes their properties, and their various applications with inks; lubricating greases; oils; paints, varnishes, and lacquers; wax polishes, etc; and gives details of published work on the subject.

Solenoid Operated Emergency Release Mechanism

R. F. Landon and Partners Ltd, David Road, Poyle Trading Estate, Colnbrook, Slough, has introduced the *Kingsway* "SQR", a solenoid-operated emergency release mechanism for use in connexion with fuel oil supplies, capable of electrically releasing safety equipment in the case of emergency.

The device operates immediately there is a failure of current to the unit, whether this is produced by air thermostats, a failure of the mains supply, or by float switch in a sump breaking the supply. It is said to be considerably cheaper than the use of a solenoid valve directly in an oil line, and is not subject to failure due to the solenoid becoming gummed open by heavy oil.

Dow Participating in Spanish Petrochemicals

An agreement has been reached between Dow Chemical International Ltd SA and Union Quimica del Norte de Espana SA (Unquinesa), one of the foremost Spanish manufacturers of organic and inorganic chemicals and plastics, to construct a petrochemical complex in Spain.

Under terms of the agreement, Dow will purchase a new issue of Unquinesa stock with a par value equal to the presently issued stock. The Spanish company, which will probably change its name to Dow-Unquinesa SA, will be entitled to technological and marketing assistance from Dow.

The development plan calls for the construction of a cracking unit which will produce ethylene and propylene. The resulting C4 fraction will be further processed to recover butadiene. Off-gas will be used in Unquinesa's existing methanol plant, substituting for gasified carbon materials.

New Edition of Motorists' Manual

Castrol's well-known manual *Car Care*, first published in 1938, has reached its nineteenth edition. The new edition has been completely rewritten and is full of information useful to every motorist.

Lubrication is fully covered in all its aspects, and there are many other chapters on such subjects as winter motoring, starting problems, running-in, and hydraulic and electrical systems.

Of particular interest to the non-technical reader is the chapter "How the Engine Works". This explains, in simple terms, the purpose and operation of such components as the carburettor, distributor, valves, clutch, and so on. Other chapters are for the more advanced do-it-yourself motorist who will find much interesting information on lubrication engineering, gearbox design, and the hypoid rear axle.

Car Care has 56 pages and 30 illustrations, and can be obtained free from Castrol Ltd, Castrol House, Marylebone Road, London, N.W.1.

New Corrosion Control System

Minneapolis-Honeywell Regulator Company, Philadelphia, has concluded an exclusive world-wide licensing agreement with Continental Oil Company to manufacture and market *Anotrol*, a new electro-chemical system for controlling corrosion. It will be offered initially in the storage and processing of sulphuric and certain other corrosive acids, as well as corrosive caustics. A "passive film" is developed and maintained on the internal surfaces of metal vessels by passing a direct current from a specially-designed electrode, acting as a cathode, through the corrosive liquid to the vessel, which itself serves as the anode.

Improved Semi-Automatic Welding Process

Rockweld Ltd, Commerce Way, Croydon, Surrey, has introduced the *Comet* Series II process for semi-automatic welding, which embodies several improvements.

The original equipment was intended for use with the Rockweld *Autopak* welding transformer. In the new version, the design enables it to be supplied by any welding power source of sufficient capacity, either AC or DC. The head has been modified and control of arc volts simplified, whilst the CO_2 cylinder is now mounted on the trolley which transports the equipment.

Advisory Service on Industrial Effluent

Simon-Carves Ltd and Monsanto Chemicals Ltd have pooled their research, engineering, and operating experience in the treatment and harmless disposal of industrial effluent to form the Simon-Carves Monsanto Effluent Advisory Service. The service is administered by Simon-Carves Ltd from their headquarters at Cheadle Heath, Stockport, Cheshire.

Both at home and overseas the service provides general advice on effluent problems, on site and laboratory investigations on the treatment of specific effluents, recommendations and design data for effluent treatment processes and plants, and continuing advice on the operation of commissioned treatment plants.

In addition the full engineering and contracting organization of Simon-Carves Ltd is available for the actual construction, installation, and commissioning of complete effluent treatment plants.

"Gredag" Greases and Compounds

A booklet containing an up-to-date list of *Gredag* greases and compounds has been published by Acheson Colloids Ltd.

The grades listed are arranged in seven sections: calcium, sodium, and lithium (soap base); bentone base; mixed base and special compounds; glassworking lubricants; and metal working lubricants. The information includes the characteristics and advantages of each grade, its consistency, and, where applicable, solids content and melting point.

Protection and Insulation of Buried Piping

Croxton & Garry Ltd, 16–18 High Street, Kingston-on-Thames, Surrey, are marketing *Protexulate*, a fine mineral powder, prepared by a patented process for use in underground pipe installations. It provides buried heating pipes with highly-efficient thermal insulation and complete protection from corrosion at advantageous overall costs.

Fisher Valves at Grangemouth Ethylene Plant

The Fisher Governor Company Ltd has provided automatic control valves and equipment for British Hydrocarbon Chemical's new No 3 ethylene plant at Grangemouth.

The new plant has some 200 pneumatic control valves ranging from 1 to 10-in in size. The inner valve is controlled by air pressure from a pneumatic instrument, which acts on a flexible diaphragm opposed by a strong spring. Valve bodies and other wearing parts are in metals able to withstand the various corrosive and erosive effects of the different fluids encountered.

Most of the pneumatic instruments incorporate Fisher 67 FR-type filter regulators. Over 400 of these devices are used throughout the plant to ensure a constant supply of clean, dry air to the controllers.

Aircraft Refuelling at Roadside Garage

A garage at Caister-on-Sea, Norfolk, in addition to its normal service, supplies BP aviation spirit to small light aircraft and helicopters which taxi in to land behind the site, as seen in the accompanying picture.

The garage, which is situated alongside the Yarmouth road, has an aviation pump and 3000 gal twin-tank storage for aviation fuels at the rear of the forecourt, and the aircraft are fuelled by means of a long boom. The garage owner is the owner of two Austers with which he operates a holiday flights service from the spot; and an increasing number of businessmen, week-end flyers, etc., are also using the facilities.

The garage owner's two Austers parked in the airfield by the aviation fuel pump at the rear of the forecourt

New Thompson-Watts Plotter

Hilger & Watts Ltd, 98 St Pancras Way, Camden Road, London, N.W.1, has introduced a new version of the Thompson-Watts plotter. The basic design of the Model 2 instrument is the same as that for the Model 1A, and Fourcard's principle of complete separation of relative and absolute orientation has been retained, together with the variable magnification feature.

The new plotter for mapping from air photographs at all scales omits facilities for mechanical air-triangulation because of the trend towards photographic control by analytical methods.

Rate of Wear Tests on Rocol Molyspeed

Recent tests carried out by the Institut Français du Pétrole to assess the value of molybdenum disulphide addition to lubricating oils, using 6 per cent Rocol *Molyspeed* and employing radioactive tracer techniques to give direct information regarding the performance of a component *in situ*, have shown that *Molyspeed* reduced the rate of wear in a Renault *Dauphine*, driven in and around Paris in traffic conditions, by 64 per cent.

The basic oil employed was a high-grade premium motor oil containing conventional anti-oxidant and anti-wear additives. Details as to results obtained are available from Rocol Ltd, Rocol House, Swillington, nr Leeds.

Corrosion-Resistant Tank

Poxyglas—a new type of corrosion-resistant tank—is now available from Black, Sivall & Bryson Inc, 7500 East Twelfth Street, Kansas City 26, Missouri, in sizes of up to 12 ft in diameter.

An epoxy resin-bonded, glass filament-wound tank, it is particularly applicable in the storage of sour crudes, waterflood and salt water disposal processes, and for offshore and other areas where external corrosion is a problem.

New Shell Worm Axle Lubricant

Shell Dentax W, a new Shell worm axle lubricant, is now being marketed by Shell-Mex and B.P. Ltd.

A synthetic lubricant made by a patented process, it yields a low coefficient of friction, and incorporates a special oxidation inhibitor which gives it remarkable stability.

Its characteristics include: specific gravity at 60 F, 1·025; viscosity index, 140; pour point, −25 F.

The lubricant comes within the SAE 90 classification, although for an oil with the viscosity/temperature characteristics of this lubricant, the classification has little relevance.

Pyrolysis Gasoline Antioxidant

A new publication from the Heavy Organic Chemicals Division of ICI Ltd deals with *Topanol* AN, an antioxidant for converting the highly unstable liquid hydrocarbon fractions produced in high-temperature cracking processes into stable and marketable gasoline. By adopting inhibitor stabilization with this method it is said that an increase in the gasoline yield of 5–15 per cent can usually be obtained without loss of leaded research octane rating.

Topanol AN—a mixture of phenolic compounds—is a liquid at atmospheric temperature and pressure, and is readily soluble in hydrocarbon oils and distillates. It has a low volatility, and a flash point of about 190 F (88 C) by the Pensky-Martens method.

Crystal Inhibitor for Oil Products

A new crystal inhibitor, *Claricol*, for use in extending the cold test of edible and non-edible oils and oil products, and for use in winterizing these oils, is announced by Beacon Chemical Industries Inc, of Cambridge, Mass.

"Jetube Vitreous Enamelling"

A new leaflet from The Incandescent Heat Company Ltd, Cornwall Road, Smethwick, Birmingham, is entitled *Jetube Vitreous Enamelling*. It concerns the high recirculation radiant tube elements developed by the Company for application to vitreous enamelling in all types of processes.

Transistor-Plug

Electro Methods Ltd, Hitchin Street, Biggleswade, Bedfordshire, has announced details of a miniature transistor-plug and socket, type M9T, with four contacts, which provides a convenient method of plug-in connexion eliminating the risk of damage that can result from re-soldering.

The same company has also released details of series 'BHM' plugs suitable for soldering into ½-in diameter holes in metal containers or bulkheads.

Latex Technical Service in Rotterdam

Dow Chemical International Ltd SA has announced the establishment of latex technical service facilities and a quality control laboratory in Rotterdam which will be built and operated in conjunction with the styrene-butadiene latex plant now under construction in the third petroleum harbour.

Cameron Ball Valve

A new valve developed by Cameron Iron Works Inc, Houston has no bonnets, gaskets, or joints—using the principle of rotating seats. The new ball design requires no lubrication to seal bubble-tight, is compact in size, and weighs only a fraction as much as others designed in its class.

It performs at a saving even in highly abrasive and corrosive fluids, and may be installed in the most convenient position—without regard to top or bottom. The two-seat construction seals both upstream and down, thus the line may be blocked in both directions and the body of the valve bled off.

Petroleum Chemicals by Flexible Tank for First Time

For the first time, ICI Heavy Organic Chemicals Division has used a flexible *Portolite* tank to transport a consignment of one of their petroleum chemical products by road. Two thousand gallons (over 7 tons) of *iso*-octanol were carried to a U.K. customer from the Division's works at Billingham, Co. Durham. The round trip was one of several hundred miles.

The tank was filled on the deck of the flat-bottomed lorry in a normal manner, and was then lashed down with ropes; no built-up sides were required. When full, the container measured some 15 ft in length and 8 ft in width, with a height of 2 ft 6 in. For the return journey the empty container was rolled up to take up only about 3 ft of the lorry's deck.

Portolite flexible tanks are made by Marston Excelsior Ltd, an ICI subsidiary. The container used for this consignment had an interior lining of rayon-reinforced butyl rubber which, being inert to *iso*-octanol, ensured that the product arrived at the customer's works in the same condition of high purity as when it left Billingham.

New Audco Diaphragm Valve

The new model 1550 split body single-seated diaphragm valve has been developed by Audco Annin Division of Audley Engineering Company Ltd, Eastern Avenue, Gloucester, to supplement the range of its Domotor valves for the simpler applications which do not justify the use of a positioner. It retains all the advantages of split body construction used with the Domotor-operated valves, and sub-assemblies of body and actuator are interchanegable.

Acquisition of Alley & MacLellan

G. & J. Weir Ltd is to acquire the complete business of Alley and MacLellan (Polmadie) Ltd.

In addition to continuing the manufacture of compressors to "Alley" designs, G. & J. Weir undertakes to maintain and operate, without interruption, spares and service facilities to customers of Alley and MacLellan and its subsidiary company, Browett Lindley (1952) Ltd.

James Gordon Indicators

Two recent publications issued by James Gordon & Co. Ltd, Dalston Gardens, Stanmore, Middlesex, describe the *Igema* distance boiler water level indicator, and the Elliott Btu meter for measuring quantities of heat dissipated in hot water circulating systems, respectively.

New Rapid Oil Packaging Equipment

A new oil packaging installation at Esso Petroleum Co's Mode Wheel terminal incorporates equipment for filling lubricating oil SAE 10 to SAE 140 viscosity into one pint and one quart bottles at a speed of 60 containers/min on either size.

This type of plant has reduced the amount of floor space required for such an operation, increased the potential capacity of the filling station by 100 per cent, and reduced the number of operatives from 8 to 3. The installation was effected by Mather & Platt Ltd, Park Works, Manchester 10, in conjunction with Esso technicians, Dawson Bros of Leeds, and Fords (Finsbury) Ltd.

Odour Control Compounds

A product for masking unpleasant odours associated with a variety of processes and products, entitled *Alamask* odour control compound, is now manufactured by May & Baker Ltd, Dagenham, Essex.

The various types of *Alamask* compounds are usually applied by means of steam or compressed air, but direct addition in liquid form is also possible. The compounds are available for use in all types of refinery and chemical plant, for application to many petroleum products, and in diesel vehicle fumes.

Pre-Engineered Buildings

The first of a new series of leaflets issued by Coseley Buildings Ltd, Lanesfield, Wolverhampton, describes with the aid of photographs some of the latticed steel frame buildings which have been erected by the Company for a variety of uses.

BP Fuelling Vehicles for "Bluebird"

When Donald Campbell made his attempt on the world land speed record at Bonneville Salt Flats, Utah, two specially-designed vehicles were used to dispense BP fuel and lubricants to the Bluebird car. The vehicles are identical, and gave a service at each end of the 14-mile course.

The fuelling packs on the vehicles were developed from initial BP designs by the De Havilland Engine Co. Ltd, constructed by Vandyke Engineering Ltd, and are mounted in standard 30-cwt vans.

Each vehicle can carry 50 gal of turbine kerosine fuel, which is pumped to the car via a combined micro-filter/separator, discharge hose, and nozzle. Before new transmission oil can be pumped to the car, the used hot oil is pumped out of the gearboxes by means of the car pump, direct into a storage tank on the fuelling vehicle for later disposal. In each vehicle, 40 gal of new transmission oil is available for pumping into the cart through a closed circuit, incorporating non-drip, self-sealing couplings. Other products, such as special greases and lubricants, will be carried for manual loading.

The self-sealing couplings and nozzles were provided by Avery-Hardoll Ltd, and the fuel micro-filter equipment was supplied by Simmonds Aerocessories.

New Nozzle Extractor Tool

Shandon Scientific Company Ltd, Combustion Instruments & Accessories Division, 6 Cromwell Place, London, S.W.7, has introduced the *Ideal* nozzle extractor.

It enables oil-burner nozzles to be removed or replaced in 40 sec—without moving the burner assembly and without any danger of damaging the electrodes. The tool is inserted through the fire door, and fits all normal types and makes of nozzles.

Tank Gauges for Norwegian Refinery

Automatic tank gauging equipment for installation at the new Slagen, Norway, refinery has now been delivered to Esso-Raffineriet, Norge, by Firth Cleveland Instruments Ltd, Treforest, Glamorgan. The order was placed through Bechtel International Ltd, and includes equipment for the detection of liquid level in all the major storage tanks of the refinery, with facilities for data display at a central control console.

Compact Pipe Bender

Chamberlain Industries Ltd, of Staffa Works, Argall Avenue, Leyton, London, E.10, announces the introduction of a completely new type of bender to their range of *Staffa* tube and pipe bending machines.

Designated the *Field* bender, it has been especially designed as a lightweight two-stage hydraulic unit, primarily for site work in oilfields and construction projects.

The substitution of the orthodox heavy beam or winghead by hinged arms, which fold into a neat compact unit, enables the machine to be made extremely portable for easy transportation.

Field benders are supplied in two sizes, one with a range of formers for bending pipe of 2–4-in bore and the other for bending pipe of 4–8-in bore.

Expansion Joint for High-Pressure Ducting

A new type of restraint method for accommodating in an atomic power station the considerable thermal expansions of the ducting conveying the coolant gas from the reactor to the heat exchanger has recently been developed by Richardsons Westgarth and Company Ltd, PO Box 2, Wallsend, Northumberland.

It works entirely on elastic deformation principles, whereby a multiplicity of high tensile bars, arranged in two groups into two fruste-conical assemblies, and spread uniformly around the periphery of the duct, transmit entirely uniformly the axial forces. Richardsons Westgarth is also investigating the use of the restraint in other applications requiring high-pressure and high-temperature ducting, including designs for operating temperatures of the order of 600 C.

High-Pressure Components for Ammonia Synthesis

Reference was made in an earlier issue to the new plant being constructed by M. W. Kellogg for Solar Nitrogen Chemicals Inc, near Joplin, Missouri. One feature of the plant is the air-cooled heat exchange equipment designed and built by Hudson Engineering Corp for a total heat dissipation of 37,120,000 Btu/hr: the design pressure of the ammonia converter effluent cooler being 5000 psi, and the test pressure of the methanol condenser 11,500 psi.

Phenol Plant in Rotterdam

A new phenol plant in the Botlek area of Rotterdam will be jointly owned by Staatsmijnen in Limburg and Dow Chemie AG, the Swiss subsidiary of The Dow Chemical Company. An important portion of the production will be used for the phenol requirements of the former company, and the remainder will be marketed by Dow.

Phenol is one of the most important raw materials for caprolactam, an essential ingredient in the manufacture of nylon, and whose production was initiated by Staatsmijnen in Limburg in 1952.

Water Treatment Processes

A recent agreement made between the Belco Industrial Equipment Division, of New Jersey, and Head Wrightson Processes, has enabled the latter organization to offer the Belco water treatment processes.

A booklet published by Head Wrightson & Co. Ltd, Ship House, 20 Buckingham Gate, London, S.W.1, describes the processes offered by the Company in the field of water demineralization, with a general guide to their application, and includes tables of conversion for chemicals and water analysis units.

New Platinum Reforming Catalysts

Cyanamid-Ketjen NV, Amsterdam, producers of platinum reforming catalysts, has started the commercial production of three new types, named CK-303, CK-306, and CK-307.

The new $\frac{1}{16}$-in extruded catalysts may be considered an improvement on the types CK-103 and CK-106, and can be used in any type of platinum reforming unit under high and low-pressure operating conditions, giving improved yields of high-octane gasoline, and are fully regenerable.

Fisher Valves at Pernis Synthetic Rubber Plant

More than 450 valves manufactured by the Fisher Governor Co. Ltd are used in the automatic control of Shell International's new synthetic rubber plant at Pernis, Holland. Automatic control valves are used in process lines throughout the plant, and also in the cooling and heating of the processes themselves. They range from $\frac{1}{2}$–14-in in pipe diameter, and are of the spring-opposed diaphragm type, operated by a pneumatic controller.

Many different fluids are involved, and pressures range from near vacuum to many thousands of psi, temperatures from well below zero to near red-heat, and flow rates from a mere trickle to thousands of gal/hr.

Aluminium Alloy Road Tanker

The A.P.V. Company Ltd, Crawley, Sussex, are exhibiting an aluminium alloy 4000 gal petroleum tank mounted on an Atkinson L1786 8-wheeled chassis, at the International Commercial Motor Transport Exhibition in London.

It is an elliptical tank divided into five equal compartments, each compartment being fitted with a Collins-Wallis 18$\frac{3}{4}$-in diameter manway, with vacuum/pressure vessel and dipping connexion and a Collins-Wallis top-operated foot valve.

New "Activated" Engine Oil

A new type of oil, specially formulated to reduce engine wear and improve performance, is announced by the Vigzol Oil Co. Ltd.

An "activated" oil, it repairs the major deficiency of multi-grade oils—inadequate adhesion to metal surfaces—whilst retaining all their other advantages. An adequate oil film is provided from a cold start, and acid corrosion of the engine is now eliminated.

Activated Vitaflow is available in SAE 10W/30 or 20/W40 from the Vigzol Oil Co. Ltd, Vigzol House, Greenwich, London, S.E.10.

Glandless and Seal-Less Pumps for U.K.

The manufacture and sale in the U.K. of the American *Chempumps* will be handled by British Chempump Corp Ltd, an associate of L. A. Mitchell Ltd, Harvester House, 37 Peter Street, Manchester 2.

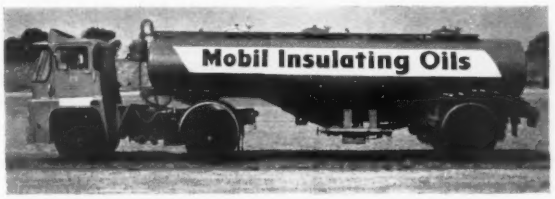
The pumps which will be made available dispense with any form of gland or mechanical seal, or shaft sealing device. Thus all parts coming into contact with the pumped fluid are of corrosion-resistant materials. The types of pump include small models for boosting pipeline flow, high temperature versions with built-in cooling circuits, and a double-ended model for high heads in which the two impellers may be used either in series or in parallel.

L. A. Mitchell Ltd has also produced a new leaflet describing its pilot-scale and laboratory process equipment.

New Type of Road Tanker

A new type of articulated vehicle comprising a lubricating and insulating oil lagged tank trailer with a Guy Invincible tractor has been added to Mobil Oil Company's fleet of road tanker vehicles.

Built by the Steel Barrel Company of Uxbridge, the tank trailer, comprising 3 × 1200 gal lined compartments, was designed to



ensure that the centre of gravity of the vehicle was as low as possible to increase stability. The rear axle makes use of a Carrimore "four-in-line" wheel arrangement in place of the conventional leaf springs with through axle. Air suspension has also been used. For the carriage of insulating oils, it has been necessary to provide a breathing manifold incorporating a dessicant filter.

Dow Applies to Build Polythene Plant in Japan

Asahi-Dow Ltd, an associate of The Dow Chemical Company, has proposed the construction of a polyethylene plant at Kawasaki to the Japanese Government. The new plant would use the high-pressure AFGO polyethylene process developed by AG für Olefin-polymerisation.

The principal licensor of the process, Scientific Design Company Inc, New York, recently concluded a contract authorizing Dow's Swiss subsidiary, Dow Chemie AG, to use the process in several countries on a non-exclusive basis for the benefit of its manufacturing subsidiaries and associated companies. In Japan, however, Scientific Design agreed that the licence be granted exclusively to Asahi-Dow.

New High-Temperature Lube Oil Additive

Development of a new additive to combat high-temperature deterioration of lubricating oil, and reduce bearing corrosion, has been announced by Universal Oil Products Company, 30 Algonquin Road, Des Plaines, Illinois. Designated UOP-225, the additive contains no metal or phosphorus, it is stable at temperatures above 500 F and leaves no combustion ash, and is completely soluble in petroleum and synthetic lubricants.

First applications probably will be in heavy-duty greases. Advantages of the new additive include corrosion protection for all bearing metals plus titanium, aluminium, and magnesium. The inhibitor is compatible with common lube and transmission oil detergents and is also suitable for transformer oils. It is insoluble in water, a property which, in addition to high-temperature stability, makes it ideal for steam turbine lubricants.

APV—Sivyer Agreement

A licensing arrangement has been reached between the Sivyer Steel Casting Company of Milwaukee, Wisconsin, and APV-Paramount Ltd of Crawley, Sussex, whereby the latter is to manufacture and sell *Sivyer* refinery fittings in Europe and in the British Commonwealth.

A. P. Newall Change of Address

The London Office of A. P. Newall & Co. Ltd has been moved to 19–20 Grosvenor Street, London, W.1. (HYDe Park 3342).

Clark Compressors to be Built in Glasgow

G. & J. Weir Ltd, of Glasgow, has been licensed by Clark Bros Co., Division of Dresser (G.B.) Ltd, 197 Knightsbridge, London, S.W.7, to manufacture their line of *Isotemp* packaged centrifugal air compressors.

The compressors are designed in seven frame sizes with capacities of 5000 to over 50,000 cu ft/min.

Intrinsic Safety Certificate for Gauge

The level detecting system of the Gilbarco-Firth Cleveland electronic automatic tank contents gauge has been granted an Intrinsic Safety Certificate No IS 3096 (Hydrogen/Ethylene/Pentane Classes) by HM Factory Inspectorate, Ministry of Labour.

Cambridge Instrument Events

The August edition of the *Cambridge News* published by the Cambridge Instrument Co. Ltd, gives short illustrated accounts of the receptions held at its headquarters at 13 Grosvenor Place, London, S.W.1 to celebrate the merging of the Company with Electronic Instruments Ltd; and of the Cambridge participation in the recent SIMA exhibition in Moscow.

Chemical Demulsifiers

Tretolite Company divisions of Petrolite Corp have available a new comprehensive 16-page brochure on *Tret-o-Lite* chemical demulsifiers for petroleum producers.

The various application methods are described, and the uses and types of emulsions and demulsifiers are detailed with the aid of illustrations. Copies may be obtained from Petrolite Ltd, Heathcoat House, 20 Savile Row, London, W.1.

* * *

Situations Vacant

Oil Refinery Technician, now actually in charge either of running part of a refinery plant, or of inspection and control of processes, who also knows from personal experience the problems involved in the selection and application of refractory linings, is required to call on the major oil companies and principal contractors to establish our refractory products in that field. We are a Company of long standing who have in the past 3 years introduced in the U.K. an entirely new range, now accepted and specified in other Industries. Salary considered would be £1000 p.a. initially, plus bonus after 12 months. Pension scheme and B.U.P.A. in operation. Car supplied. Considerable travelling will be involved, both in U.K. and Western Europe. Write in strict confidence to "Managing Director", Box No. 1134, *IP Review*.

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The preference is for men who have had three to ten years post-graduate experience, for whom the starting salary would be up to £1600 p.a. commensurate with experience and qualifications, but those who have less than three years post-graduate experience may also apply, in which case the starting salary would not be less than £1300 p.a.

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* * *

Forthcoming Meetings

THE INSTITUTE

(At 61 New Cavendish Street, London, W.1, 5.30 p.m.—tea 5 p.m.)

The Changing Energy Pattern in Europe and its Possible Effect on Product-Mix. M. E. Hubbard, B.A., M.I.Mech.E., M. Inst. F. **7 December**

IP ESSEX BRANCH

(At Bull Hotel, Pitsea, 7.30 p.m.)

Low Temperature Engineering. E. H. Adams. **9 November**
Brains Trust **14 December**

IP FAWLEY BRANCH

(At the Potters Heron Hotel, Ampfield)

Dinner-Dance. **25 November**

(At Esso (Fawley) Recreation Club, Holbury, 7.30 p.m.)

Fuels at Sea T. Kameen, M.I.Mar. E. **7 December**

IP LONDON BRANCH

(At 61 New Cavendish Street, London, W.1, 6 p.m.—tea 5.30 p.m.)

Channel Tunnel. M. A. Cameron, M.A., M.Inst.T. **23 November**
Film Show at Shell-Mex House. **2 and 9 December**

IP NORTHERN BRANCH

(At Engineers' Club, Albert Square, Manchester 2, 6.30 p.m.)

Ball Bearing Lubrication. N. A. Scarlett. **15 November**

(At Midland Hotel, Manchester)

Dinner-Dance. **25 November**

IP SCOTTISH BRANCH

(At BP Refinery Recreation Hall, Grangemouth, 7.30 p.m.)

The Mode of Action of TEL as an Anti-Knock Compound in Petrol Engines. Prof. A. D. Walsh, M.A., Ph.D. **10 November**

IP SOUTH WALES BRANCH

(At the Training Centre, BP Refinery (Llandarcy) Ltd, 5.30 p.m.)

Some Thoughts on Realistic Management in a Marketing Company. A. C. Durie. **16 November**

IP STANLOW BRANCH

(At Lecture Theatre, Grosvenor Museum, Chester, 7.30 p.m.)

The Application of the Alkali Act. F. E. Ireland, B.Sc., F.R.I.C., M.I.Chem.E., M.Inst.F. **16 November**

IP YORKSHIRE BRANCH

(At Great Northern Hotel, Leeds, 7 p.m.)

Testing of Materials in Automobile Production. J. E. James. **9 November**

(At George and Dragon Hotel, Apperley Bridge, nr. Bradford, 7 p.m.)

Pea and Pie Supper **7 December**

THE SOCIETY OF INSTRUMENT TECHNOLOGY

(At the Welsh College of Advanced Technology, Cardiff, 6.45 p.m.)

The Application and Selection of Automatic Control Valves. P. Stone. **30 November**

THE CHEMICAL SOCIETY

(At Department of Chemistry, Trinity College, Dublin, 7.45 p.m.)

Chemicals from Petroleum. Dr R. Holroyd, M.Sc., F.R.S. **2 December**

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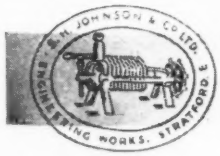

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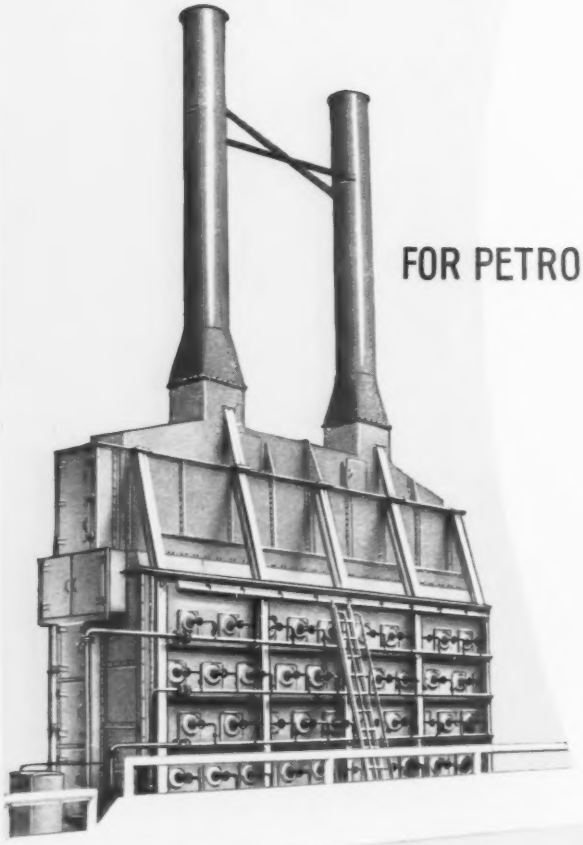

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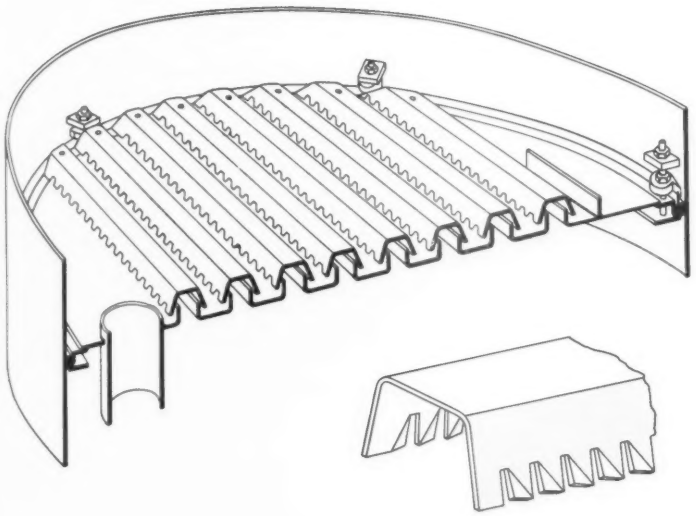

COPPEE hold the exclusive licence for the United Kingdom for the supply of **COPPEE-MONTZ** plates. In contrast to the usual form of plate, this new plate is not a disc with bubble-caps sitting over vapour pipes. It is built up of U-shaped (or similar) troughs, as will be seen from the illustration. Adjacent troughs form liquid channels and vapour ducts, the latter being covered by inverted U-troughs having slots on their lower edges. **COPPEE-MONTZ** plates can be supplied already assembled for mounting in a column or, where necessary, they can be broken down into sections for easy assembly inside any column where projections may prohibit the installation of complete plates. At the hydro-refining plant being built for the Port Talbot Chemical Co. Ltd. (owned jointly by the Steel Company of Wales and the Lincolnshire Chemical Co. Ltd.) crude coke oven benzol will be refined to produce pure benzol. The distillation equipment designed by R. and J. Dempster Ltd. in conjunction with Lurgi incorporates **COPPEE-MONTZ** plates, of which 185 will be used in this important plant.

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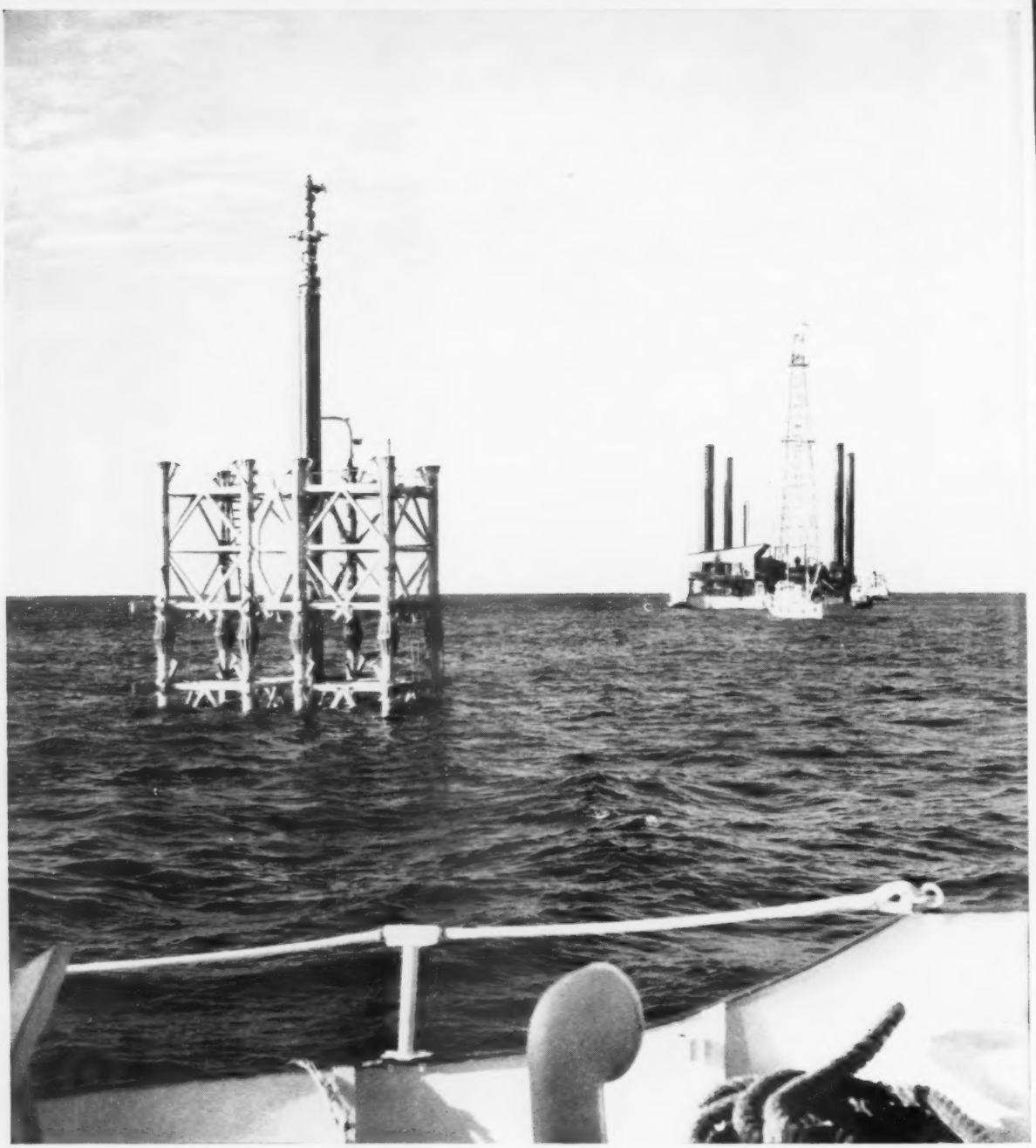
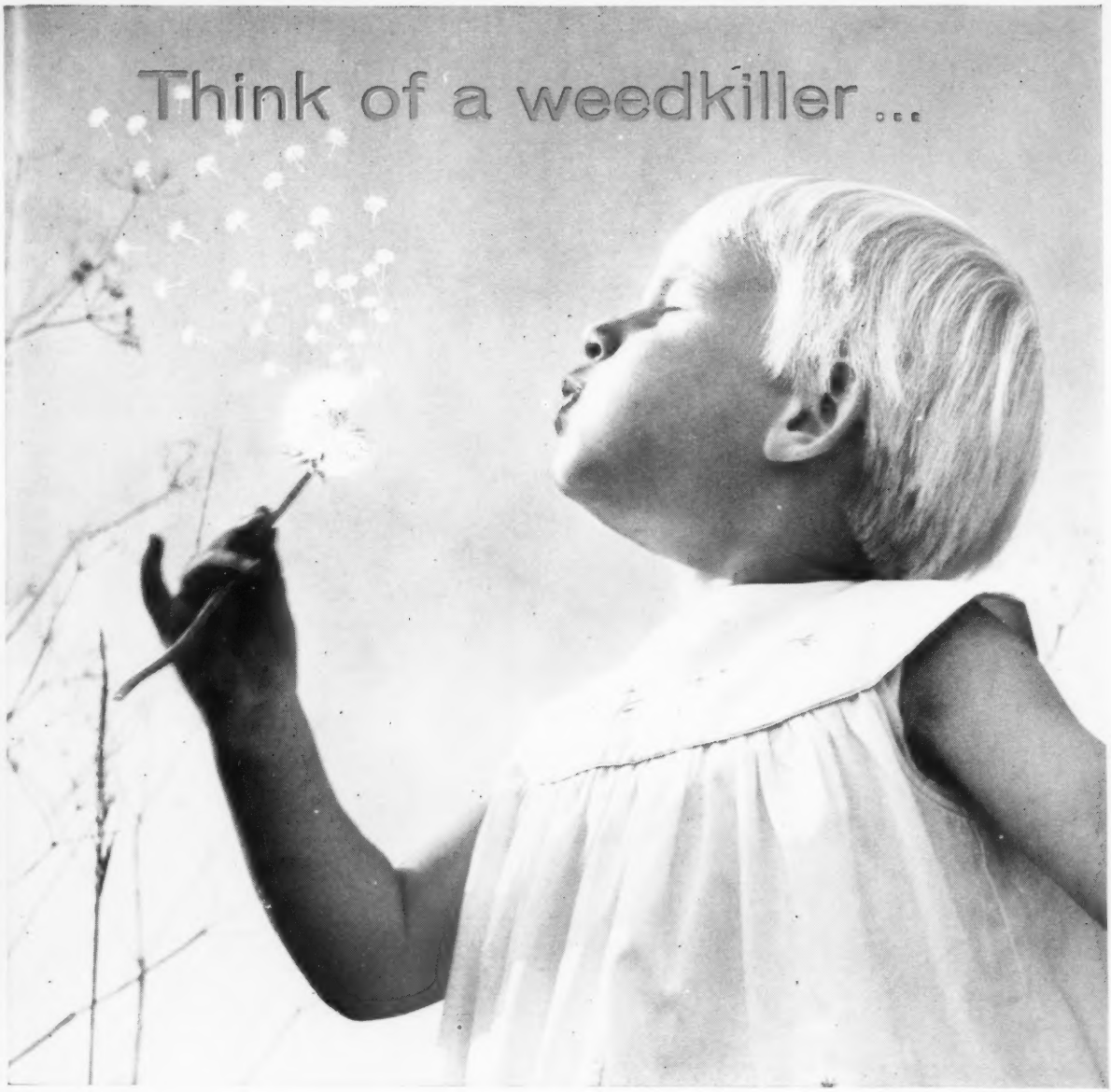


ABU DHABI

A well head in the Persian Gulf. In the background, the barge "Adma Enterprise" which is currently drilling beneath the waters of the Gulf. The results are sufficiently encouraging to warrant the preparation of facilities for regular production. This stage should be reached by mid-1962.

BP



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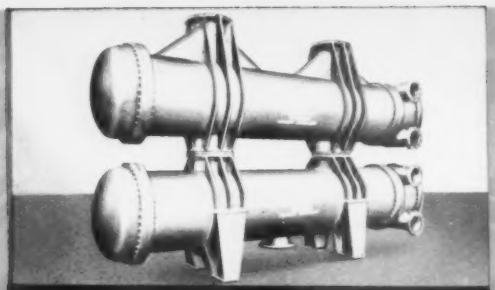

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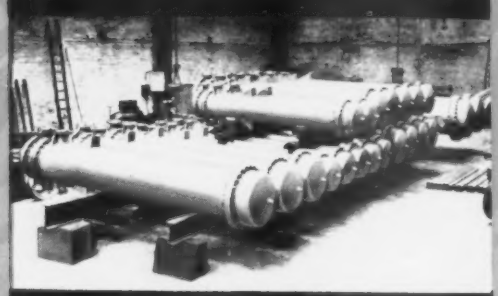

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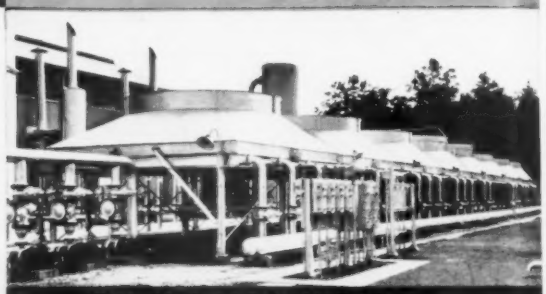
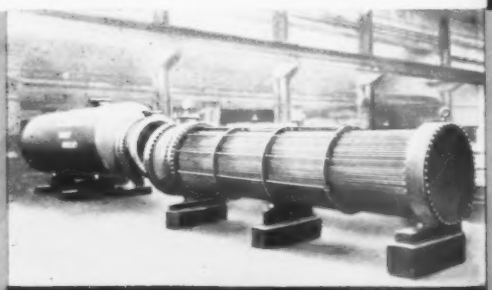
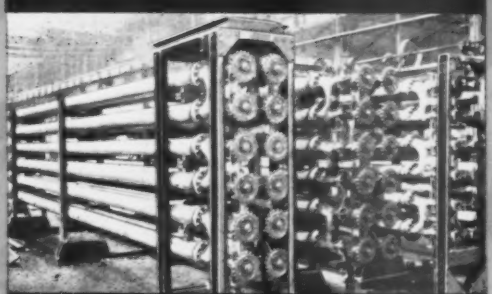


Craig-Hudson Solo-Air Exchangers -induced draught



Reboiler Shell and Tube Bundle



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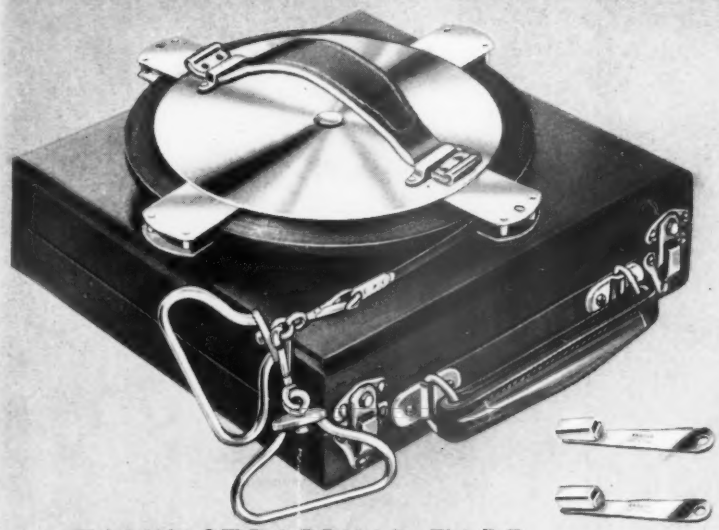

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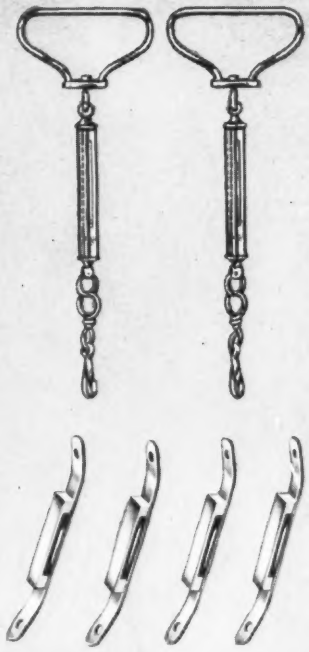

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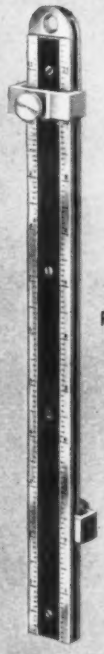

WATER
FINDING
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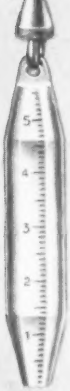

DEPTH
WEIGHT
No. 610

DEPTH
WEIGHT
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ULLAGE
RULE
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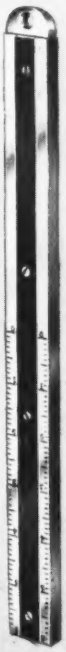

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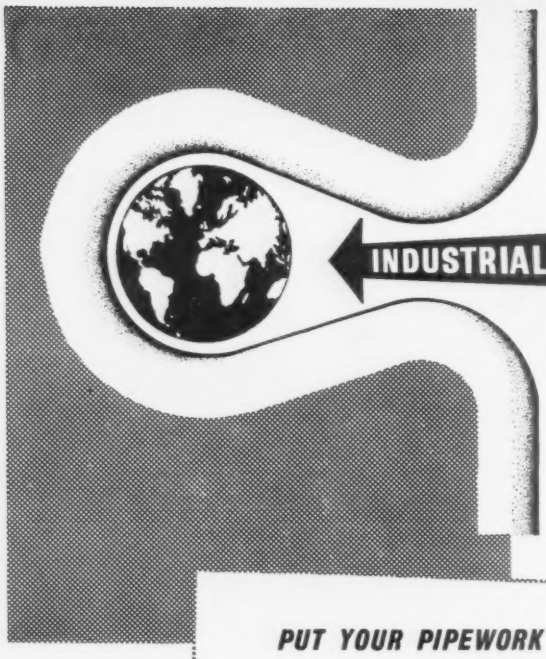

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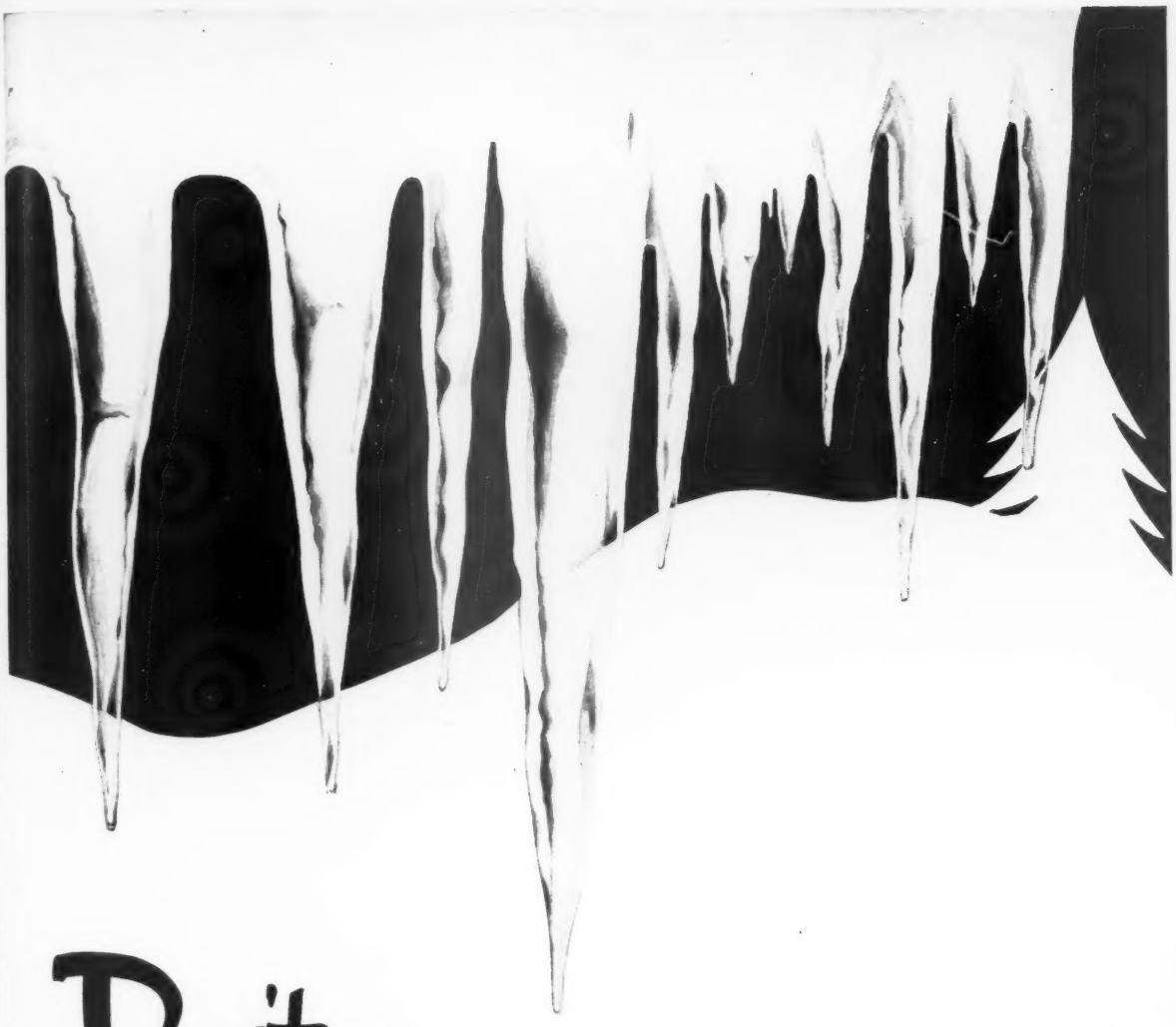

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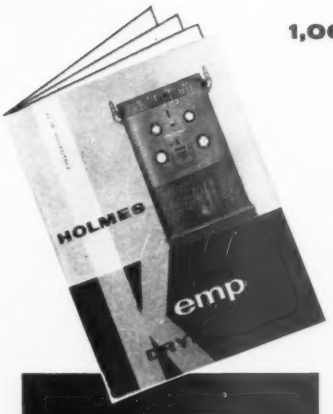

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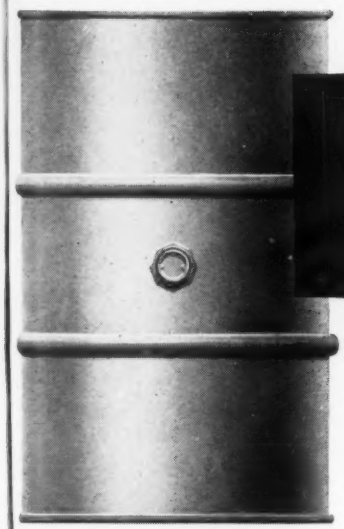

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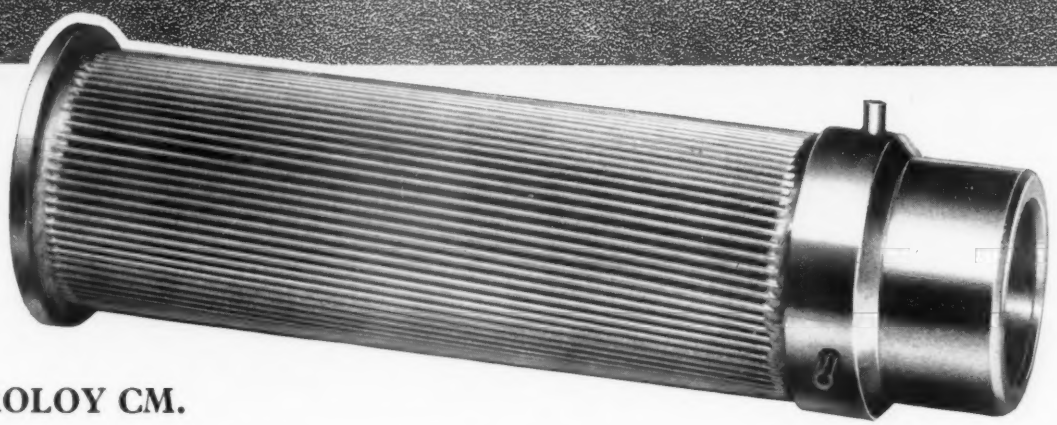

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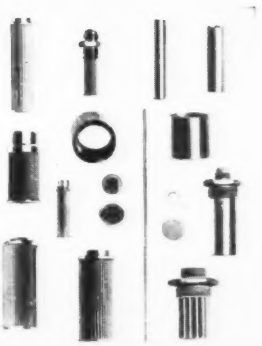

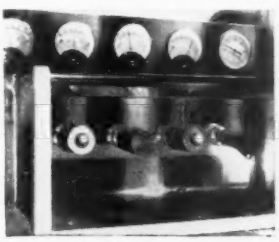

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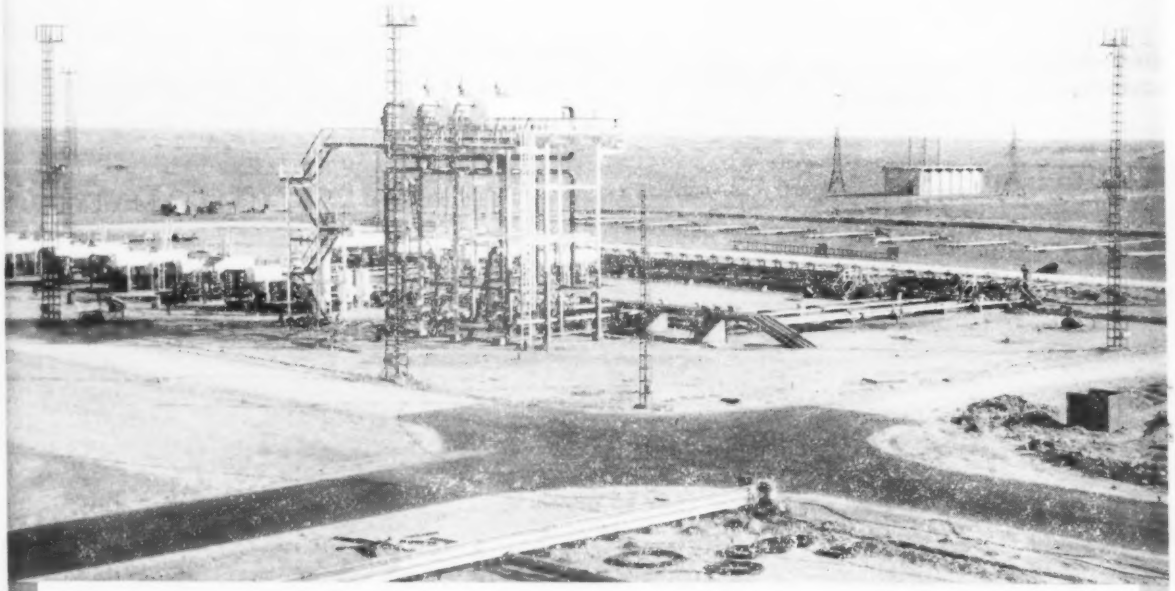

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